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BRYOLOGIE LICHENOLOGIE

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DESCRIPTIONS AND ILLUSTRATIONS OF BARBULA, PSEUDOCROSSIDIUM AND BRYOERYTHROPHYLLUM (P.P.) OF MEXICO

R.H. ZANDER *

SUMMARY. — The genera *Barbula* and *Pseudocrossidium* are redescribed and their Mexican species redescribed and illustrated in a full, modern manner. Two Mexican species of *Bryoerythrophyllum* until recently recognised as taxa of *Barbula* are fully redescribed and illustrated. Keys are given to the three genera and to their Mexican species. *Barbula indica* var. *gregaria* (Mitt.) is a comb. et stat. nov.

Key-words : Mosses, Mexico, *Barbula*, *Pseudocrossidium*, *Bryoerythrophyllum*.

The three genera *Barbula* Hedw., *Pseudocrossidium* Williams and *Bryoerythrophyllum* Chen each have at least some species that together share several salient characteristics : twisted peristomes (WILLIAMS 1915, ZANDER 1978 a, b, 1979, 1980); leaves with differentiated basal cells and costae with two stereid bands and differentiated ad- and abaxial epidermises; laminal papillae multiplex and crowded; and axillary hairs of hyaline cells alone. The genera are distinguishable, however, by the key given below, which emphasizes what are apparently three different evolutionary directions.

KEY TO BARBULA, PSEUDOCROSSIDIUM AND BRYOERYTHROPHYLLUM

1. Dioicous or monoicous; lower leaves reddish in nature, laminae K (10% KOH) usually medium to deep red or red-brown; laminal papillae hollow, sometimes solid; basal laminal cells sometimes hyaline, inflated, and bulging; peristome usually of short, straight or rudimentary teeth, seldom long and twisted *Bryoerythrophyllum*
1. Dioicous; lower leaves brown, seldom reddish in nature, laminae K (10% KOH) usually light to deep yellow or yellow-brown to orange-brown; laminal papillae solid or hollow; basal laminal cells light brown, with straight walls, not bulging; peristome usually long and twisted. 2

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2. Perichaetial leaves in many species strongly differentiated, convolute-sheathing and largely prosenchymatous; photosynthetic organs formed in many species either by highly revolute and chlorophyllose leaf margins or adaxial coastal cells forming a pad of filaments, or both; adaxial stereid band of costa usually absent, but hydroids usually present; cells more papillose on lamina medially than at leaf margins (except in coils of revolute portion). *Pseudocrossidium*
2. Perichaetial leaves not differentiated or sheathing the seta in lower half, seldom convolute-sheathing, seldom largely prosenchymatous; no part of costa or lamina specialized as photosynthetic organ; adaxial stereid band usually present, hydroids absent in most species; lamina usually evenly papillose *Barbula*

The full descriptions and illustrations provided here for species of these genera are intended to support recent re-evaluations of generic limits (SAITO 1975, ZANDER 1978a, b, 1979, 1980) of *Barbula* and related genera in the Pottiaceae, and are based on examined specimens from many herbaria, but chiefly BM, BUF, CANM, FH, MICH, NY, PC, SPA, TENN and US. Synonymy given here is restricted to names with Mexican types; other names in synonymy may be found in the papers cited above. Mexican distribution is based largely on specimens examined, but also on citations by CRUM (1951). The chromosome numbers given are taken from the literature.

BARBULA HEDW., Spec. Musc. : 115, 1801, nom. cons.

Plants loosely caespitose to cushion-forming, green to yellow- or black-brown. Stems mostly 0.2-3.0 cm long, central strand present. Leaves spatulate to lanceolate or long-triangular, ventrally broadly concave or narrowly channelled, margins entire to weakly dentate, plane to recurved, leaf apex rounded to acute, leaf base weakly differentiated to sheathing the stem; costa ending a few cells below the apex to short-excurrent, ventral and dorsal surficial cells quadrate to elongate, papillose or smooth; costa in transverse section round to semicircular, epidermal layers differentiated, adaxial stereid band usually differentiated, guide cells usually 2-4, hydroids (Begleiter cells) sometimes present, dorsal stereid band usually strong; upper laminal cells subquadrate to short-rectangular, walls thin to evenly thickened, surficially flat on both surfaces to weakly convex or bulging adaxially, laminal papillae absent or solid to hollow, often centered over the lumens, often multiplex; basal laminal cells usually differentiated, rectangular smooth to weakly papillose. Dioicous (two species possibly rhizautoicous). Gametoeceia terminal, perigonia gemmate; perichaetial leaves ovate to long-lanceolate, often enlarged, occasionally strongly sheathing the seta, laminal cells usually prosenchymatous in lower half of leaf. Sporophyte seta elongate, twisted clockwise below, often counterclockwise above; theca short- to long-cylindrical; stomata at base of theca, phaneropore; annulus of 1-2 rows of vesiculose cells usually differentiated, occasionally revolute or

deciduous in parts; peristome weakly or strongly twisted, of 32, linear usually densely spiculate teeth, basal membrane low. Operculum short- to long-conic. Calyptra cucullate, smooth. Laminal color reactions (after clearing in concentrated lactic acid): Cl (conc. HCl): medium green to bright yellow-green usually predominating + light to medium yellow-brown to orange-brown, occasionally light brown; K (10% KOH): green seldom present, light to deep yellow-brown to orange-brown; N (conc. HNO_3): light to deep red or red-brown, occasionally light to dark orange or light brown; SE (H_2SO_4 -ethanol, 2:1): green usually present + light to medium yellow-brown to orange-brown or light brown, seldom light red throughout or with deep red blotches.

KEY TO SPECIES OF *BARBULA* IN MEXICO

1. Leaves spatulate, laminal cells smooth, adaxially bulging and abaxially nearly plane, annulus revolute 6. *B. agraria* Hedw.
1. Leaves lanceolate to ovate, laminal cells papillose to nearly smooth, similar on both surfaces or somewhat more strongly convex adaxially than abaxially, annulus persistent 2
2. Leaves flaccid when wet, upper laminal cells rectangular, usually smooth, often adaxially more convex than abaxially 3
2. Leaves firm when wet, upper laminal cells subquadrate, papillose, both exposed surfaces similar 4
3. Leaves ovate-lanceolate, margins usually plane, laminal cells 11-15 μm wide, 1(-2):1 4. *B. ehrenbergii* (Lor.) Fleisch.
3. Leaves narrowly lanceolate to long-triangular, margins narrowly recurved to near apex, laminal cells 8-12 μm wide, 1-2:1 5. *B. arcuata* Griff.
4. Upper leaf margins recurved to near apex 1. *B. orizabensis* C. Muell.
4. Upper leaf margins plane 5
5. Abaxial costa surface doubly prorulose (i.e., with both ends of rectangular surficial cells protruding) near apex, often coarsely mamillate or very rough in appearance; propagula often present in leaf axils, occasionally on basal rhizoids 2. *B. indica* (Hook.) Spreng.
5. Abaxial costa surface with hollow or solid, scattered papillae; propagula (when present) on basal rhizoids only 3. *B. convoluta* Hedw.

1. *BARBULA ORIZABENSIS* C. MUELL., *Linnaea* 38: 638, 1874. **Type**: Mexico, Veracruz, Orizaba, Mohr, 1874 (NY, topotype).
 — *Barbula stenotheca* Thér., *Smiths. Misc. Coll.* 85 (4): 21, 1931. **Type**: Mexico, Distrito Federal, Río Frío, Amable 1726 (PC, holotype).

Plants turf-forming, occasionally with branches ascending from procumbent stems, yellow-green above, brown below. Stems often branching, brown, 1.5-

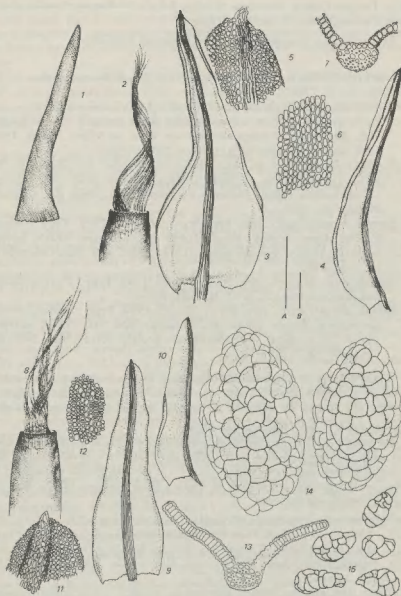
2.5 cm long, in transverse section pentagonal, central strand strong, cortex of smaller, darker cells, hyalodermis absent; axillary hairs of 6-10 hyaline, uniseriate cells. Leaves when dry appressed-incurved and spiralled around the stem, when wet spreading to 60° , ligulate to oblong, mostly 1.5-1.9 mm long, adaxial surface narrowly grooved along costa; leaf margins revolute or narrowly recurved to near apex, entire but extreme apex often slightly denticulate; leaf apex obtuse to rounded; leaf base ovate, basal margins short-decurrent; costa short-excurrent as a stout mucro, adaxial surficial cells quadrate to short-rectangular, papillose, adaxial surficial cells elongate, papillose, transverse section of costa semicircular, adaxial surface flat, adaxial and abaxial epidermises differentiated in one layer, adaxial stereid band weak to absent, guide cells 3-4 in one layer, hydroids (Begleiter cells) present, abaxial stereid band strong; upper laminal cells subquadrate, 7-9 μm wide, 1 : 1, walls thin to evenly thickened, bulging on both surfaces, arranged in longitudinal rows, homogeneous in shape and size; laminal papillae multiplex, massive, covering lumens; basal laminal cells weakly medially differentiated, 9-12 μm wide, 4-6 : 1, walls evenly thickened. Propagula spherical or occasionally elliptical, of 5-6 cells, 30-35 μm in diameter, borne in clusters on short stalks in leaf axils.

Dioicous. Perichaetia terminal, inner leaves oblong-lanceolate, to 3.0 mm long, lower half sheathing the seta and prosenchymatous; perigonia terminal or in pseudolateral series, gemmate, hidden by subtending leaves. Sporophyte seta 1.5-1.9 cm long, one per perichaetium, red-brown, twisted clockwise below, counterclockwise above; theca 1.9-4.2 mm long, orange-brown, smooth when dry, long-cylindrical and occasionally curved, neck absent to weakly differentiated, exothelial cells rectangular to rhomboidal, 20-25 μm wide, 2-5 : 1, walls thin; stomates at base of theca, phaneropore; annulus of vesiculate cells in 3 rows, not deciduous; peristome twisted counterclockwise once, of 32 long-linear, red teeth with many articulations, 500-1000 μm long, densely spiculate, basal membrane very low or absent, to 25 μm high, papillose; operculum long-conic, 1.1-1.5 mm long, cells twisted counterclockwise. Calyptra cucullate, smooth, 2.5-3.5 mm long. Spores light brown, papillose, 9-12 μm in diameter. Laminal color reactions (after conc. lactic acid clearing) : Cl (conc. HCl) : bright yellow-green or green + yellow-brown; K (10% KOH) : bright yellow-orange to medium orange; N (conc. HNO_3) : light red to red-brown; SE (H_2SO_4 -ethanol, 2 : 1) : green + light brown or yellow-brown + red blotches. Illustration : Pl. I, fig. 1-7.

Barbula orizabensis is very similar to *B. unguiculata* Hedw. in overall appearance. The latter species, which is very common in Anglo America but has not yet been found in Mexico, has an obtuse to broadly acute leaf apex and leaf margins recurved in the lower 1/2-2/3, and propagula are absent, while *B. orizabensis* is easily distinguished by the abruptly rounded to emarginate leaf apex, leaf margins recurved to near the apex, and propagula are commonly evident in the leaf axils.

Habitat : soil, rock, walls, often limestone, 910-1850 m elevation.

Mexican distribution : Baja California, Baja California Sur., Chiapas, Coa-



Pl. I. — *Barbula orizabensis* and *B. indica*. — 1-7 : *B. orizabensis*. 1 : Operculum. 2 : Peristome. 3-4 : Leaves. 5 : Leaf apex. 6 : Upper median leaf cells. 7 : Transverse section of costa. — 8-15 : *B. indica*. 8 : Peristome. 9-10 : Leaves. 11 : Leaf apex. 12 : Upper median leaf cells. 13 : Transverse section of costa. 14 : Propagula of var. *gregaria*. 15 : Propagula of var. *indica*. A = 0.5 mm; B = 50 μ m.

huila, Distrito Federal, Guerrero, Hidalgo, Jalisco, Michoacán, Morelos, Nuevo León, Puebla, Sonora, Tamaulipas, Veracruz.

Range : Mexico, Guatemala, Jamaica, Dominican Republic.

2. *BARBULA INDICA* (HOOK.) SPRENG. in Steud., Nomencl. Bot. 2 : 72, 1824.

- *Tortula indica* Hook., Musci Exot. 2 : 135, 1819, basionym, nom. nov. for *Trichostomum indicum* Schwaegr., Spec. Musc. Suppl. 1 (1) : 142, 1811, hom. illeg. non *Trichostomum indicum* Willd. ex Schrad., 1803. **Type :** India, Madras, Tranquebar, Röttler s.n. (NY, isotype).
- *Barbula rufipes* Schimp. ex Besch., Mém. Soc. Nat. Sci. Nat. Cherb. 16 : 180, 1872. **Type :** Mexico, Veracruz, Orizaba, Mueller, 1853 (BM, holotype)
– *Semibarbula rufipes* (Schimp. ex Besch.) Hilp., Beih. Bot. Centralbl. 50 (2) : 622, 1933.
- *Barbula hypselostegia* Card., Rev. Bryol. 36 : 84, 1909. **Type :** Mexico, Puebla, Honey Station, Pringle 10653 (PC, holotype; TENN, isotype)
– *Streblotrichum hypselostegium* (Card.) Hilp., Beih. Bot. Centralbl. 50 (2) : 635, 1933.
- *Barbula muenchii* Card., Rev. Bryol. 36 : 84, 1909. **Type :** Mexico, Chiapas, San Cristóbal, Muench, 1907 (NY, isotype).
- *Barbula pringlei* Card., Rev. Bryol. 36 : 85, 1909. **Type :** Mexico, Morelos, Cuernavaca, Pringle 10637 (PC, lectotype; BM, FH, TENN, isotypes), 15177 (PC, syntype) – *Streblotrichum pringlei* (Card.) Hilp., Beih. Bot. Centralbl. 50 (2) : 635, 1933.

A full description and extensive discussion of this polymorphic species are given by ZANDER (1979). Those who wish to recognise certain intergrading infraspecific variants as taxa may do so with the following scientific names :

Barbula indica (Hook.) Spreng. var. *indica*

Plants with small, green, obovoid propagula occurring in masses in the upper leaf axils, composed of 3 to several cells; leaves usually narrowly oval to elliptical, with margins plane or weakly recurved at midleaf. Found throughout the range of the species and known in Mexico from Durango, Jalisco, San Luis Potosí, Sonora, and Veracruz.

Barbula indica var. *gregaria* (Mitt.) Zander, comb. et stat. nov.

Tortula gregaria Mitt., J. Linn. Soc. Bot. London Suppl. 1 : 29, 1859, basionym. **Type :** Nepal, Tambar R., Hooker 166 (NY, syntype) – *Barbula gregaria* (Mitt.) Jaeg., Ber. S. Gall. Naturw. Ges. 1871-72 : 424, 1873 (Ad. 1 : 272).

Plants with massive, brown, elliptical to spherical, often armed propagula occurring usually 1-3 in upper leaf axils or solitary on basal rhizoids, or both, composed of up to ca. 50 cells; leaves usually broadly oval, with plane margins. Found mainly in tropical and subtropical regions, and in Mexico from the states of Chiapas, Hidalgo, Morelos, Oaxaca, Puebla, and Veracruz.

Barbula indica sensu lato.

This phrase may be used to name collections that lack propagula or which have propagula of intermediate morphology. Such specimens do not extend the known Mexican distribution of the species beyond the states mentioned above.

The names of infraspecific variants recognised here are presented in consonance with the International Rules of Botanical Nomenclature, but, because the infraspecific taxa intergrade in morphology, no heterotypic synonyms are assigned to them. Illustration : Pl. I, fig. 8-15.

3. **BARBULA CONVOLUTA** HEDW., Spec. Musc. : 120, 1801.

- *Tortula convoluta* (Hedw.) Gaertn., Meyer & Scherb., Oek. Techn. Fl. Wetterau 3 (2) : 92, 1802 - *Streblotrichum convolutum* (Hedw.) P. Beauv., Prodr. : 89, 1805.

Plants turf-forming, light to dark green above, light brown below. Stems often branching, brown, ca. 1.0-1.2 cm long, transverse section pentagonal, central strand strong, cortex of small-lumened, thicker-walled cells, hyalodermis absent; axillary hairs of 5-8 hyaline, uniseriate cells; stem with red radicles or tomentum. Leaves crowded, when dry appressed, incurved, contorted, when wet weakly to widely spreading, ligulate to ovate, 1.0-1.7 mm long, adaxial surface narrowly and deeply grooved along the costa; leaf margins weakly recurved in lower 1/3, plane above, entire but minutely crenulate by papillae; leaf apex entire or apiculate by a smooth, conical cell, rounded or broadly acute, occasionally sharply acute; leaf base ovate; costa ending (4-)6-8 cells below apex, weak, not bulging abaxially, adaxial surficial cells smooth to weakly papillose, elongate, abaxial surficial cells elongate, papillose, transverse section of costa semicircular, adaxial surface convex, epidermal cells differentiated both ad- and abaxially, abaxial epidermal cells with ovate to semicircular lumens, adaxial stereid band absent or weak, guide cells 3 in one layer, hydroids absent, abaxial stereid band strong; upper laminal cells subquadrate, 8-10 μ m wide, 1:1, walls evenly thickened, bulging on both surfaces, arranged in longitudinal and transverse rows, homogeneous in shape and size; laminal papillae multiplex, massive, centered over and covering the lumens, 4-6 salients per lumen; basal laminal cells differentiated across leaf base but higher along the costa, rectangular, 9-12(-18) μ m wide, 3-5:1, walls thin. Propagula as multicellular brood bodies on basal rhizoids, spherical to elongate-elliptical, to 1150 μ m long, deep red-brown, individual cells 25-50 μ m in diameter.

Dioicous (but possibly rhizautoicous). Perichaetia terminal, inner leaves ovate to ovate-acute, 0.8-1.0 mm long, convolute-sheathing, entirely prosenchymatous; perigonia clustered terminally on very small androgametophores situated at base of gynogametophytes, gemmate. Sporophyte seta one per perichaetium, 1.0-1.8 cm long, yellow to yellow-brown, twisted clockwise below and counterclockwise above; theca 0.8-1.3 mm long, red-brown, smooth when dry, long-elliptical, occasionally curved, neck absent to weakly differentiated, microstomous; exothecial cells rectangular-rhomboidal, 20-30 μ m wide,

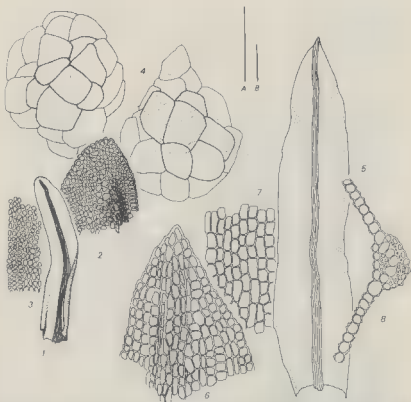
2-3 : 1, walls thick; stomates at base of theca, phaneropore; annulus deciduous, revolute; peristome twisted 1.5-2.0 times counterclockwise, of 32 long-linear, red teeth, with many articulations, spiculate, 700-1300 μm long, basal membrane low, ca. 45-55 μm high, papillose; operculum long-conic, 0.8-1.2 mm long, cells twisted counterclockwise. Calyptra cucullate, smooth, 1.8-2.1 mm long. Spores light brown, essentially smooth, 10-12 μm in diameter. Lamina color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : bright yellow-green; K (10% KOH) : deep yellow-orange; N (conc. HNO_3) : medium to deep red; SE (H_2SO_4 -ethanol, 2 : 1) : green + medium yellow- or orange-brown. $n = 11, 13, 14$. Illustration : Pl. II, fig. 1-4.

Barbula convoluta is widely distributed in the North Temperate Zone and disjunct to New Zealand, but I have seen only one collection from Mexico (reported by KOCH & CRUM 1950) : Baja California Sur., Sierra de la Laguna, La Laguna, E of Todos Santos, canyon W of cabin, granite gravel under edge of rack, Carter 2372 (MICH).

4. *BARBULA EHRENBERGII* (LOR.) FLEISCH., Musci Arch Indic. Exs. ser. 4, n. 161, 1901.

- *Trichostomum ehrenbergii* Lor., Abhandl. Akad. Wiss. Berlin 1867 : 25, 1868, basionym.
- *Barbula ehrenbergii* var. *mexicana* Thér., Smiths. Misc. Coll. 85 (4) : 19, 1931. Type : Mexico, Nuevo León, Monterrey, Abbon 10969 (PC, holotype).

Plants loosely caespitose to turf-forming, green above, brown to light tan below. Stems branching little, red-brown, 1.0-3.5 cm long, in transverse section pentagonal, central strand present, cortex weakly differentiated, hyalodermis absent; axillary hairs of 5-9 uniseriate, hyaline cells; stem often incrustated with carbonate deposits. Leaves when dry erect and weakly incurved, when wet patent at 45° , long elliptical to short-ligulate, 2.0-2.7 mm long, adaxial surface flat to broadly channeled across leaf; leaf margins recurved in lower 1/2-3/4, entire or denticulate at apex; leaf apex narrowly to broadly obtuse; leaf base scarcely differentiated in shape to ovate, basal margins decurrent; costa percurrent or subpercurrent by 2-3 cells, dorsally bulging, adaxial and abaxial surficial cells short-rectangular to elongate, smooth, transverse section of costa semicircular, adaxial surface weakly convex, adaxial and abaxial epidermises differentiated, abaxial epidermis lumens hexagonal, adaxial and abaxial stereid bands strong, guide cells 3-5 in one layer, hydroids absent; upper laminal cells subquadrate to short-rectangular, 11-15(-16) μm wide. 1-2 : 1, walls thin to evenly thickened, bulging more adaxially than abaxially, arranged in longitudinal and, often, in transverse rows, somewhat larger in size medially; laminal papillae usually absent, occasionally low, small, hollow, simple, 4-6 over each lumen; basal laminal cells differentiated across leaf and higher on the margins, rectangular, mostly 16-27 μm wide, 3-4 : 1, cell walls evenly thickened or thin, hyaline, marginal cells occasionally prorulose. Propagula borne in leaf axils on stalks, corniculate (branching-stellate) or filamentous, multicellular, to 180 μm long.



Pl. II. — *Barbula convoluta* and *B. ehrenbergii*. — 1-4 : *B. convoluta*. 1 : Leaf. 2 : Leaf apex. 3 : Upper median cells. 4 : Rhizoidal propagula. — 5-8 : *B. ehrenbergii*. 5 : Leaf. 6 : Leaf apex. 7 : Upper median cells. 8 : Transverse section of costa. A = 0,5 mm; B = 50 μ m.

Sporophyte seta deep red, paler red to yellow above, to 2 cm long; theca oval to oval-cylindrical, 1-2 mm long; peristome to 600 μ m long, twisted once clockwise, of pale red to transparent, fragile teeth, basal membrane low; operculum long-rostrate, to 2 mm long. Spores ca. 2 μ m in diameter (sporophyte and spore characters from CHEN 1941 and STEERE 1937). Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : green + light yellow-brown to tan; K (10% KOH) : light yellow-brown to medium orange-brown; N (conc. HNO_3) : light orange-brown to red or tan; SE (H_2SO_4 -ethanol, 2 : 1) : green + light orange-brown to yellow-orange-brown or brown. n = 13. Illustration : Pl. II, fig. 5-8.

Barbula ehrenbergii is a North Temperate Zone species very closely related to the more tropically distributed *B. arcuata*, and some specimens cannot be assigned to either taxon with certainty.



Habitat : wet, calcareous rocks, often in waterfalls, springs or running water, often tufa-forming, 650-1700 m elevation.

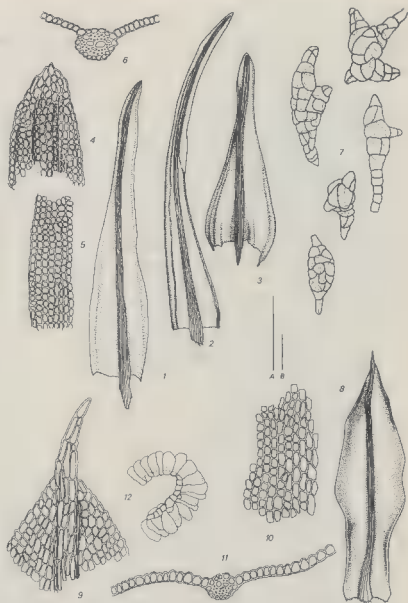
Mexican distribution : Chihuahua, Coahuila, Nuevo León, San Luis Potosí.

Range : southern U.S.A., Mexico, Belize, Europe, northern Africa, eastern Asia and the Middle East.

5. *BARBULA ARCUATA* GRIFF., *Calcutta J. Nat. Hist.* 2 : 491, 1842. **Type** : India, Griffith 27 (BM, holotype).
 — *Hydrogonium arcuatum* (Griff.) Wijk & Marg., *Taxon* 7 : 289, 1958.
 — *Barbula stillicidiorum* Card., *Rev. Bryol.* 37 : 126, 1910. **Type** : Mexico, Veracruz, Barnes & Land, 1906 (NY, isotype).
 — *Barbula rubricaulis* Thér., *Smiths. Misc. Coll.* 85 (4) : 19, 1931. **Type** : Mexico, Nuevo León, Monterrey, Abbon 10968 (FH, isotype).

Plants loosely caespitose or turf-forming, yellow-green above, tan or occasionally brown to red-brown below. Stems little branching, red-brown to dark red, 1.0-2.5 cm long, in transverse section pentagonal, central strand distinct to strong, cortex of smaller, more thick-walled cells, hyalodermis not differentiated; axially hairs of 3-6 cells, all hyaline or basal cell brown. Leaves rather distant, when dry weakly spreading from insertion, apices curled, often catenulate, appressed-twisted, incurved, when wet weakly spreading, long-triangular to lanceolate, 1.1-2.0 mm long, adaxial surface broadly channeled across leaf to narrowly grooved medially with a channel about twice as wide as the costa; leaf margins narrowly recurved from base to near apex, occasionally revolute below, entire but denticulate at extreme apex; leaf apex often somewhat cucullate; leaf base scarcely differentiated in shape, basal margins scarcely decurrent to decurrent by hyaline, inflated cells; costa percurrent, often sinuose near apex, adaxial surficial cells elongate, 3-5 : 1, abaxial surficial cells rectangular, 2-4 : 1, transverse section of costa above midleaf round to semicircular, adaxial surface convex, ad- and abaxial costal epidermises differentiated, lumens of abaxial epidermis oval, adaxial stereid band absent, guide cells 3-4 in one layer, hydroids absent, abaxial stereid band weak to strong; upper laminal cells short-rectangular, 7-10(-12) μ m wide, 1-2 : 1, walls thin to evenly thickened and somewhat porose, bulging more adaxially than abaxially, arranged in longitudinal rows, relatively homogeneous in size and shape; laminal papillae absent; basal laminal cells weakly differentiated, short-rectangular, to 14 μ m wide, 3-4 : 1, walls evenly thickened, medial cells occasionally brownish. Propagula corniculate (branching-stellate), fusiform or armed, borne on branching brown stalks in leaf axils, median cells to 45 μ m in diameter, composed of 12-15 cells, to 135(-185) μ m long.

Dioicous. Perichaetia terminal, inner leaves weakly differentiated, to 1.5 mm long, vaginula often large and prominent; perigonia terminal or in pseudolateral series, gemmate and often prominent. Sporophyte seta one per perichaetium, 0.8-1.7 mm long, red-brown, twisted clockwise; theca 0.8-2.5 mm long, yellow to red-brown, smooth to striated when dry, short-cylindrical, neck weakly



Pl. III. - *Barbula arcuata* and *B. agraria*. - 1-7: *B. arcuata*. 1-3: Leaves. 4: Leaf apex. 5: Upper marginal cells. 6: Transverse section of costa. 7: Corniculate propagula. - 8-12: *B. agraria*. 8: Leaf. 9: Leaf apex. 10: Upper median cells. 11: Transverse section of leaf. 12: Revolvable annulus. A = 0.5 mm; B = 50 μ m.

differentiated, occasionally ventricose when short; exothelial cells rectangular, 23-25 μm wide, 3-4 : 1, walls thin to evenly thickened; stomates present at base of theca, phaneropore; annulus of 2-3 rows of vesiculose cells; peristome twisted 1.5-2.0 times, of 32 long-linear, red-orange, densely spiculose teeth with many articulations, to 900-1200 μm long, basal membrane low, 45-80 μm high, densely spiculose, often perforate; operculum long-conic, 1.0-1.7 mm long, cells twisted counterclockwise. Calyptra cucullate, smooth, 2.2-3.0 mm long. Spores light brown, weakly papillose, 12-14(-16) μm in diameter. Laminar color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : yellow-green (occasionally yellow); K (10% KOH) : deep yellow or bright yellow-orange; N (conc. HNO_3) : light red, occasionally light tan; SE (H_2SO_4 -ethanol, 2 : 1) : green + yellow-brown, occasionally light brown, occasionally with red blotches. $n = 13, 13 + 1$. Illustration : Pl. III, fig. 1-7.

Barbula arcuata is extremely variable in leaf shape, varying from the elliptical leaves typical of *B. ehrenbergii* to very narrow, subulate leaves characteristic of many specimens from the West Indies. This species often grows with and looks much like narrow-leaved, hygric forms of *B. indica* but differs in its long-triangular leaves with 1-3 apical teeth, costa abaxially smooth or sharply crenulate by projecting cell cross walls, and laminar cells smooth, short-rectangular.

Habitat : wet cliffs, riverbanks, calcareous soil, wet rock, travertine, 150-1350 m elevation.

Mexican distribution : Nuevo León, Veracruz.

Range : Mexico, Guatemala, Cuba, Haiti, Dominican Republic, Jamaica, Puerto Rico, Guadeloupe, Venezuela, India, Burma, Indonesia, Molucca, New Guinea, Philippines, China, Japan, western Oceania.

6. *BARBULA AGRARIA* HEDW., Spec. Musc. : 116, 1801. Type : «Jamaica et Domingo», Swartz s.n. (G, syntype; BM, syntype?).

– *Tortula agraria* (Hedw.) P. Beauv., Prodr. : 91, 1805.

Plants loosely caespitose to turf-forming, green above, brown below. Stems little branched, to 0.2 cm long, in transverse section irregularly pentagonal, central strand very strong or stem hollow, cortex not differentiated or of one layer of thick-walled cells, hyalodermis absent; axillary hairs of ca. 2 uniseriate, hyaline cells; stem often highly radiculose. Leaves when dry appressed to weakly spreading, incurved, when wet weakly spreading to 45°, oblong, elliptical or spatulate, 1.2-2.0 mm long, adaxial surface broadly channelled to concave; leaf margins plane, entire to weakly serrulate apically, marginal cells thick-walled and rhomboidal near apex; leaf apex broadly acute; leaf base oblong, margins often winged; costa stoutly short-excurrent as a sharp, often curved mucro, occasionally percurrent, ad- and abaxial surficial cells elongate, smooth, transverse section of costa oval, adaxial surface convex, adaxial epidermis present, abaxial epidermis present, with oval lumens, or occasionally absent, adaxial stereid band weak, guide cells 2 in one layer, hydroids absent, abaxial stereid band strong; upper laminar cells subquadrate to short-rectangular or rhomboidal,

(8-)11-13(-15) μm wide, 1-2 : 1, occasionally bistratose in patches along margins or medially, walls thin, occasionally evenly thickened, adaxially bulging but abaxially flat, arranged in longitudinal and occasionally transverse rows, homogeneous in size; laminal papillae absent; basal laminal cells differentiated in small area or up to 1/3 of leaf, rectangular, 20-25 μm wide, 2-4 : 1, walls thin, occasionally evenly thickened, occasionally brownish.

Dioicous (or possibly rhizautoicous, androgametophytes never found except in proximity to gynogametophytes). Gametoecea terminal, inner perichaetial leaves smaller than cauline, oval, sheathing, largely prosenchymatous, occasionally serrulate, ca. 1.5 mm long; perigonia on small plants, gemmate; seta one per perichaetium, 0.4-1.0 mm long, red-brown, twisted clockwise below, strongly counterclockwise above; theca 0.3-1.7 mm long, red-brown to brown, sulcate or strongly ribbed when dry, cylindrical to elliptical, neck weakly differentiated; exothecial cells rectangular, 16-23 μm wide, 3-5 : 1, walls thin; stomates present at base of theca, phaneropore; annulus revolute, deciduous, of 1-2 rows of strongly vesiculose cells; peristome twisted counterclockwise 1.5-2.0 times, of 32 long-linear, orange, densely spiculose teeth with many articulations, 500-1200 μm long, basal membrane low, 45-100 μm high, closely and evenly granulate or densely spiculose, trabeculate; operculum long-conic, 0.8-1.5 mm long, cells twisted 2-3 times counterclockwise. Calyptra cucullate, smooth, 1.4-2.1 mm long. Spores light brown, weakly papillose, 9-11 μm in diameter. Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : deep yellow or yellow-green + medium yellow-brown; K (10% KOH) : medium orange to deep yellow-orange; N (HNO_3) : light red; SE (H_2SO_4 -ethanol, 2 : 1) : light orange-brown or medium yellow-brown to medium brown. Illustration : Pl. III, fig. 8-12.

Barbula agraria differs widely from other species of *Barbula* by the spatulate leaf shape, the epapillose, adaxially bulging laminal cells (but those of *B. arcuatum* and *B. ehrenbergii* are somewhat similar), and the revolute annulus, and has been assigned to a monotypic subgenus, *Barbula* subg. *Hyophiladelphus* (C. Muell.) Zander.

Habitat : soil, rock, walls, coral, limestone, sandstone, brick, to 350 m elevation.

Mexican distribution : Campeche, Hidalgo, Quintana Roo, San Luis Potosí, Veracruz, Yucatán.

Range : Mexico, Guatemala, West Indies, northern South America.

EXCLUDED TAXA

Several taxa of *Barbula* have recently been excluded from the genus. These are discussed by ZANDER (1978a, 1979, 1980); two of these species are fully described and illustrated later in the present paper as species of *Bryoerythrophyllum*.

PSEUDOCROSSIDIUM WILLIAMS,
Bull. Torrey Bot. Club 42 : 396, 1915.

- *Barbula* sect. *Revolutae* B.S.G., *Bryol. Eur.* 2 : 89, 1842 (fasc. 13-15 Mon. 27). — *Barbula* subsect. *Revolutae* (B.S.G.) Chen, *Hedwigia* 80 : 209, 1941.

Plants in cushions or turf, green to brown or red-brown. Stems mostly 0.3-1.5 cm long, central strand usually present. Leaves ovate to lanceolate, ventrally channelled along the costa, margins entire, recurved and little differentiated to strongly revolute and differentiated as a photosynthetic organ of thin-walled, highly chlorophyllose, hollow-papillose cells; leaf apex acute to rounded; leaf base scarcely differentiated to oblong; costa excurrent, mucronate or short-awned, adaxial surficial cells quadrate to short-rectangular, papillose, in South American species differentiated as a photosynthetic organ of a pad of filaments of uniseriate cells, abaxial surficial cells differentiated as an epidermis of cells with lumens larger than those of the stericid cells, adaxial stericid band usually absent, guide cells 4(-9) in one layer, hydroids (Begleiter cells) often present, dorsal stericid band usually strong; upper laminal cells subquadrate to hexagonal, walls evenly thickened, surficially bulging; laminal papillae crowded, low, hollow, multiplex; basal laminal cells differentiated medially, rectangular. Dioicous. Gametoeceia terminal, perigonia gemmate, perichaetial leaves little different from the cauline to highly differentiated, enlarged, convolute-sheathing, largely prosenchymatous. Sporophyte seta elongate, twisted clockwise; theca elliptical to cylindrical; stomata at base of theca, phaneropore; annulus of 3-4 rows of vesiculose cells; peristome weakly to once twisted, of 32 linear, densely spiculose teeth, basal membrane absent or low; operculum short- to long-conic. Calyptra cucullate, smooth. Laminal color reactions (after clearing in concentrated lactic acid) : Cl (conc. HCl) : green or yellow-green + bright to medium yellow or yellow-orange, occasionally orange-brown, leaf tips occasionally orange; K (10% KOH) : deep yellow-orange or yellow, occasionally medium orange or orange-brown; N (HNO₃) : light to deep red, occasionally light brown; SE (H₂SO₄-ethanol, 2 : 1) : green + medium yellow-brown or light orange-brown, occasionally red-orange at leaf tips or medial blotches.

Pseudocrossidium and *Barbula* species are rather alike in morphology, and in acid-base laminal color reactions, except for the technical characters given in the key above. ZANDER (1979) distinguishes all North American species of *Pseudocrossidium* and *Barbula* in a single key and also provides a key to South American species of *Pseudocrossidium*.

KEY TO MEXICAN SPECIES OF *PSEUDOCROSSIDIUM*

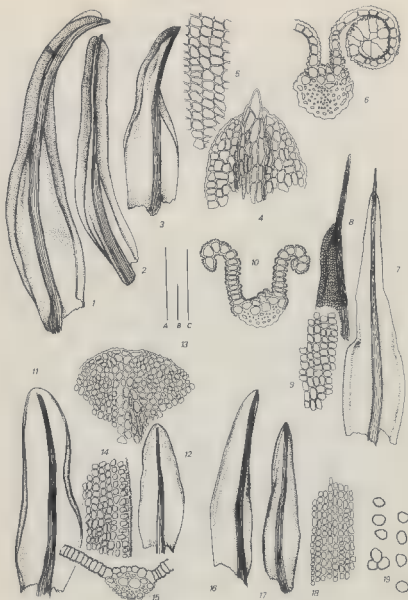
- Leaves short-awned, leaf margins recurved, not markedly differentiated.
 2. *P. aureum* (Bartr.) Zander
 Leaves mucronate, leaf margins spiral-revolute, of thin-walled, hollow-papillose,
 highly chlorophyllose cells 1. *P. replicatum* (Tayl.) Zander

1. *PSEUDOCROSSIDIUM REPLICATUM* (TAYL.) ZANDER, *Phytologia* 44 : 206, 1979.

- *Barbula replicata* Tayl., *London J. Bot.* 5 : 49, 1846, basionym. Type : Ecuador, Pichincha, Quito, Jameson 103 (BM, isotype) – *Tortula replicata* (Tayl.) Wils., *London J. Bot.* 5 : 454, 1846.
- *Barbula spiralis* Schimp. ex C. Muell., *Syn. Musc.* 1 : 622, 1849. Type : Mexico, Veracruz, Yarrea, Mirador, Liebmann, 1842 (BM, isotype) – *Tortula spiralis* (Schimp. ex C. Muell.) Mitt., *J. Linn. Soc. Bot.* 12 : 151, 1869.
- *Barbula spiralis* var. *emarginata* Card., *Rev. Bryol.* 36 : 84, 1909. Type : Mexico, Mexico, Amecameca, Pringle 10611 (M, MEXU, F, FH, isotypes).

Plants in cushions or turf-forming, yellow-green above, red below. Stems often branching, red-brown, 0.3-1.5 cm long, in transverse section pentagonal, central strand strong, stem occasionally hollow, cortex of one layer of substereid cells, hyalodermis not differentiated; axillary hairs of 5-7 uniseriate, hyaline cells; stem sparsely radiculose. Leaves when dry appressed, spiralled, when wet spreading-recurved to 45°, ovate-ligulate to ovate-lanceolate, 1.0-1.8(-2.6) mm long, adaxial surface narrowly and deeply grooved along the costa; leaf margins spiral-revolute to near apex, entire, verrucose with small papillae or smooth on exposed surfaces, internally differentiated as ■ photosynthetic organ of thin-walled, hollow-papillose, highly chlorophyllose cells; leaf apex broadly acute to rounded; leaf base ovate to oblong; costa of even width to near apex or wider above midleaf, short-excurrent as ■ sharp, smooth mucro of 1-3 cells, occasionally cuspidate, adaxial surficial cells quadrate above midleaf, papillose, abaxial surficial cells rectangular, papillose, transverse section of costa circular to reniform, adaxial surface convex to concave, ad- and abaxial epidermises differentiated in one layer, lumens of abaxial epidermis semicircular, cells of abaxial epidermis lateral to costa wide-lumened, similar to adaxial surficial cells, adaxial stereid band absent or represented by a few substereid cells, guide cells 4(-6) in 1(-2) layers, hydroids (Begleiter cells) present, abaxial stereid band strong; upper laminal cells subquadrate to hexagonal, medially 8-9 µm wide, 1 : 1, occasionally transversely elongate on margins, 1 : 1(-3), walls thin, occasionally thickened on adaxial surface, surficially bulging on both sides, not distinctively patterned; laminal papillae, low, hollow, crowded, multiplex, several salients per lumen; basal laminal cells differentiated medially in leaf base, occasionally across leaf base, short-rectangular, to 11 µm wide, walls evenly thickened to hyaline, somewhat bulging, inner medial cells often orange.

Diocious, androgametophytes often in separate turf. Gametoecea terminal; perichaetial leaves little different from cauline leaves; perigonia gemmate. Sporophyte seta one per perichaetium, 1.0-1.4 mm long, red- to yellow-brown, twisted clockwise; theca 1.6-2.5(-3.5) mm long, red- to yellow-brown, smooth when dry, elliptical to cylindrical, neck weakly differentiated; exothelial cells short-rectangular, 16-20 µm wide, 2-3 : 1, walls thin; stomates on base of theca, phaneropore; annulus of 3-4 rows of vesiculose cells, not deciduous; peristome weakly to once twisted counterclockwise, of 32 filamentous, orange to yellow, densely spiculate teeth, with many articulations, (700-)900-1000 µm long, basal mem-



Pl. IV. - *Pseudocrossidium replicatum*, *P. aureum*, *Bryoerythrophyllum calcareum* and *B. inaequalifolium*. 1-6 : *P. replicatum* 1-3 : Leaves. 4 : Leaf apex. 5 : Upper median leaf cells. 6 : Transverse section of costa. - 7-10 : *P. aureum*. 7 : Leaf. 8 : Leaf apex. 9 : Upper median leaf cells. 10 : Transverse section of leaf. - 11-15 : *B. calcareum*. 11-12 : Leaves. 13 : Leaf apex. 14 : Upper marginal cells. 15 : Transverse section of costa. - 16-19 : *B. inaequalifolium*. 16-17 : Leaves. 18 : Upper median leaf cells. 19 : Unicellular propagula. A = 0.5 mm; B = 50 μ m; C = 100 μ m.

brane absent or low, to 35(–70) μm high, weakly spiculose; operculum short-to long-conic, 0.6–1.0(–2.1) mm long, cells twisted counterclockwise. Calyptra cucullate, smooth, 3.2–3.5 mm long. Spores light brown, weakly papillose, 9–10 μm in diameter. Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : green to yellow-green + bright yellow or yellow-orange, occasionally leaf tips orange; K (10% KOH) : deep yellow or yellow-orange, occasionally medium orange-brown; N (conc. HNO_3) : deep red, occasionally light to medium red; SE (H_2SO_4 -ethanol, 2 : 1) : green + medium yellow-brown or light orange-brown, occasionally leaf tips red-orange. Illustration : Pl. IV, fig. 1–6.

Collections of *Pseudocrossidium replicatum* in Mexico are on the whole somewhat smaller in plant size than are those from South America. *Pseudocrossidium revolutum* (Brid. in Schrad.) Zander is known from southern California (ZANDER 1979) and should be looked for in Mexico – it differs from *P. replicatum* by its only once-revolute leaf margins, propagula born on the adaxial surface of the costa, and highly differentiated perichaetial leaves.

Habitat : soil, rock, concrete, lava, adobe, walls, 750–2590 m elevation.

Mexican distribution : Chiapas, Chihuahua, Coahuila, Colima, Distrito Federal, Durango, Hidalgo, Jalisco, Mexico, Michoacán, Morelos, Nuevo León, Oaxaca, Puebla, San Luis Potosí, Sonora, Tamaulipas, Tlaxcala, Veracruz.

Range : southwestern U.S.A., Mexico, northern Andes of South America.

2. **PSEUDOCROSSIDIUM AUREUM** (BARTR.) ZANDER. *Phytologia* 44 : 207, 1979.

- *Tortula aurea* Bartr., *Bull. Torrey Bot. Club* 51 : 339, 1924, basionym. Type : U.S.A., Arizona, Pima Co., Santa Catalina Mts., Bear Canyon, Bartram 307 (Bartram, Mosses of So. Arizona 98) (FH, holotype; CU, isotype) – *Barbula aurea* (Bartr.) Zander in Zander & Steere, *The Bryologist* 81 : 466, 1978.

Plants in cushions or turf-forming, green above and brown below. Stems often branching, brown, to 1.0 cm long, in transverse section rounded-pentagonal, central strand very strong, cortex weakly differentiated, hyalodermis absent; axillary hairs of 5–8 hyaline, uniseriate cells; stems weakly radiculose. Leaves when dry appressed, spiralled, when wet spreading 45–60°, lanceolate to ovate, 1.5–1.8 mm long, adaxial surface shallowly grooved along costa; leaf margins broadly and strongly recurved to near apex, entire, occasionally orange; leaf apex acute to rounded-acute; leaf base scarcely differentiated in shape to oblong; costa strong to apex, excurrent as a short, or seldom long, awn, smooth, orange, 185–360(–450) μm long, adaxial surficial cells quadrate to short-rectangular, papillose, abaxial surficial cells elongate, smooth to papillose, transverse section of costa reniform, adaxial surface concave, ad- and abaxial epidermises differentiated, lumens of abaxial epidermis semicircular, abaxial epidermal cells lateral to costa enlarged, similar to adaxial epidermal cells, often brown, thicke-

ned on surficial wall and colored with appearance of ocelli, adaxial stereid band absent, guide cells 4 in 1(-2) layers, hydroids (Begleiter cells) present, abaxial stereid band strong; upper laminal cells subquadrate to hexagonal, 12-16(-18) μm wide, 1 : 1-2 (occasionally transversely elongate along margins, walls evenly thickened, bulging on both sides, arranged in longitudinal rows; laminal papillae hollow, crowded, multiplex, with several salients per lumen; basal laminal cells usually differentiated medially in leaf base, rectangular, 11-13(-23) μm wide, 2-5 : 1, walls thin to evenly thickened.

Apparently dioicous; perichaetia terminal, inner leaves not different from cauline; perigonia and sporophyte not seen. Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : green to yellow-green + medium yellow-brown, occasionally orange-brown; K (10% KOH) : strong yellow-brown, occasionally orange; N (conc. HNO_3) : light red + light brown; SE (H_2SO_4 -ethanol, 2 : 1) : green + light to medium yellow-brown or light orange-brown, occasionally red blotches. Illustration : Pl. IV, fig. 7-10.

Pseudocrossidium aureum lacks most of the salient characteristics of the genus — the perichaetial leaves are not differentiated (presence of a seta might make a difference, but the sporophyte is unknown), there are no laminal or costal specialized photosynthetic organs, and there is no marked differentiation on medial and marginal laminal papillae. However, the costa transverse section shows a strong abaxial stereid band and the adaxial band is lacking, which distinguishes the species from *Barbula* (although small plants of some species of *Barbula* also lack the adaxial stereid band), while the abaxial costal epidermis is differentiated, which distinguishes it from most *Tortula* species. Hydroids are present in the costa. *Pseudocrossidium* is similar to *P. replicatum* in commonly developing a characteristic line of large-lumened, superficially thick-walled cells, often of a deep yellow or orange color, abaxially at the juncture of the lamina and the costa. These cells may have the appearance of a longitudinal row of ocelli on each side of the costa.

Habitat : soil, rock, canyon walls, ledges, 800-2350 m elevation.

Mexican distribution : Chihuahua, Coahuila, Hidalgo, Puebla, San Luis Potosí, Sonora, Zacatecas.

Range : southwestern U.S.A., Mexico.

BRYOERYTHROPHYLLUM CHEN (Supplement)

Two Mexican species were recently excluded from *Barbula* (ZANDER 1980), and are fully described and illustrated here as a supplement to my synopsis of *Bryoerythrophyllum* in the New World (ZANDER 1978b).

KEY TO *BRYOERYTHROPHYLLUM* SPECIES IN MEXICO

1. Leaf apex narrowly acute, entire; leaf base ovate, basal cells quadrate, 1 : 1 . . .
..... *B. recurvum* (Griff.) K. Saito
1. Leaf apex bluntly acute to broadly rounded, entire to dentate; leaf base elliptical to long-oblong, basal cells rectangular, usually 2 : 1 or longer. . . . 2
 2. Leaf apex entire, not apiculate, leaf margins recurved to near apex; propagula when present mostly unicellular, axillary 3
 2. Leaf apex entire or dentate, usually apiculate by 1-4 clear cells (if not, then margins plane above midleaf); propagula when present multicellular, borne on basal rhizoids 4
3. Leaves ovate, marginal cells not differentiated as a border; propagula common, yellow-brown, borne in axillary masses.
..... *B. inaequalifolium* (Tayl.) Zander
3. Leaves ligulate, marginal cells often thick-walled in 2-3 rows; propagula uncommon, red-brown, few in leaf axils
..... *B. calcareum* (Thér.) Zander
4. Leaf margins strongly recurved above midleaf, often to near apex; usually monoicous, sometimes dioicous
..... *B. recurvirostrum* (Hedw.) Chen
4. Leaf margins plane above midleaf or seldom weakly recurved to near apex; dioicous 5
 5. Leaves oblong to long-lanceolate, 1.0-3.5(-5.0) mm long, apex usually broadly acute to broadly obtuse, upper margins often dentate, often weakly bordered by thick-walled cells, propagula absent. *B. jamesonii* (Tayl.) Crum
 5. Leaves ovate-triangular to short-lanceolate, 1.0-1.8 mm long, apex narrowly acute to narrowly obtuse, margins entire, not bordered, propagula often present on basal rhizoids.
..... *B. ferruginascens* (Stirt.) Giac.

1. *BRYOERYTHROPHYLLUM CALCAREUM* (THÉR.) ZANDER, *The Bryologist* 83 : 232, 1980.

— *Barbula calcarea* Thér., *Smiths. Misc. Coll.* 85 (4) : 20, 1931, basionym.
Type : Mexico, Distrito Federal, Desierto, Amable 1620 (PC, lectotype; NY, isotype); Michoacán, Morelia, Loma Santa María, Arsène 4891 (PC, syntype).

Plants cushion- and turf-forming, green above, yellow- to red-brown below. Stem seldom branching, red-brown, 1.0-1.4 cm long, in transverse section rounded-pentagonal, central strand present, cortex of smaller, darker cells, hyalodermis absent; axillary hairs of ca. 7 hyaline, uniseriate cells; stems sparsely radiculose. Leaves when dry appressed to weakly spreading, when wet weakly spreading, ligulate, 0.5-1.5(-1.7) mm long, adaxial surface nearly flat across

leaf; leaf margins recurved to apex, entire, cells occasionally bistratose in patches, thick-walled, yellowish; leaf apex rounded; leaf base scarcely differentiated to oblong, short-decurrent; costa ending one to several cells below the apex and decurrent at leaf base, adaxial surficial cells quadrate to short-rectangular, papillose, abaxial surficial cells elongate, occasionally quadrate or short-rectangular, papillose, transverse section of costa reniform to elliptical, adaxial surface concave to convex, ad- and abaxial epidermises differentiated in one layer, abaxial epidermal cells with elliptical lumens, adaxial stereid band absent or represented by a few substereid cells, guide cells 2 in one layer, hydroids (Be-gleiter cells) present, abaxial stereid band distinct; upper laminal cells subquadrate to hexagonal, 7-9 μm wide, 1 : 1, walls thin, occasionally evenly thickened, bulging on both sides, arranged in much-broken longitudinal rows; laminal papillae crowded, hollow, multiplex, with several salients per lumen; basal laminal cells differentiated medially or across leaf base, rectangular, 9-12 μm wide, 2-3 : 1, walls thin. Propagula borne in leaf axils, unicellular, red-brown, angular-elliptical or elliptical, 14-20 μm wide, 1-2 : 1, not common.

Dioicous. Perichaetia terminal, inner leaves long-oblong, 1.5-2.5 mm long, convolute-sheathing in lower 1/2; perigonia terminal on budlike plants ca. 1.0 mm high, gemmate. Sporophyte seta 1(-2) per perichaetium, 0.7-1.0 mm long, light red-brown, twisted clockwise below, counterclockwise above; theca 0.7-2.0(-3.0) mm long, light brown or red-brown, cylindrical, occasionally curved, neck weakly differentiated; exothecial cells long-rectangular, 16-20 μm wide, 4-8 : 1, walls thin to weakly thickened; stomates on neck, phaneropore; annulus of ca. 2 rows of vesiculose cells, adherant; peristome twisted once counterclockwise, of 32 filamentous, densely spiculose, orange teeth, ca. 500 μm long, with many articulations, basal membrane low, 10-15 μm high, papillose; operculum long-conic, 0.5-0.8 mm long, cells twisted counterclockwise. Calyptra cucullate, smooth, 1.7-1.8 mm long. Spores yellow-brown, essentially smooth, 9-12 μm in diameter. Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : light orange-brown to medium orange; K (10% KOH) : light orange-red to medium orange; N (conc. HNO_3) : light brown; SE (H_2SO_4 -ethanol, 2 : 1) : light to dark red-brown. Illustration : Pl. IV, fig. 11-15.

This species is similar to *B. inaequalifolium* and it is sometimes difficult to distinguish the two species. In addition to the key characters, it apparently differs from the latter by the annulus not revoluble and the laminae K orange or orange-red, not dark red. These characters may be variable, however, and need to be checked in additional collections when these become available. Sterile specimens may be confused with *Didymodon* species with similar leaf shapes, but the hollow-multiplex papillae will usually serve to distinguish *B. calcareum* from these.

Habitat : soil, calcareous rock, 2600-2800 m elevation.

Mexican distribution : Distrito Federal, Mexico, Michoacán.

Range : Mexico and Guatemala.

2. *BRYOERYTHROPHYLLUM INAEQUALIFOLIUM* (TAYL.) ZANDER,
The Bryologist 83 : 232, 1980.

— *Barbula inaequalifolia* Tayl., *London J. Bot.* 5 : 49, 1846, basionym.

Plants turf-forming, green above, yellow- to red-brown below. Stems often branching, orange-brown, to 1.5 cm long, in transverse section rounded pentagonal, central strand distinct, cortex of smaller, thicker-walled cells, hyalodermis absent; axillary hairs of 6-9, hyaline, uniseriate cells. Leaves when dry appressed, incurved, when wet erect-spreading, ovate to ovate-lanceolate, 1.0-2.0 mm long, narrowly grooved along costa; leaf margins revolute to apex, entire; leaf apex rounded to obtusely acute; leaf base ovate to oblong; costa evenly thick to apcx, decurrent at base, ending 1-2 cells below apex, adaxial surficial cells quadrate, papillose, abaxial surficial cells, elongate, papillose, transverse section of costa elliptical, adaxial surface convex, ad- and abaxial epidermises differentiated in one layer, lumens of abaxial epidermis elliptical to semicircular, ad- and abaxial steroid bands strong, guide cells 4 in one layer, hydroids absent; upper laminal cells subquadrate to short-rectangular, 7-10 μ m wide, 1-2 : 1, walls thin to evenly thickened, bulging on both sides, arranged in longitudinal rows; laminal papillae crowded, hollow, multiplex, several salients per lumen; basal laminal cells differentiated across leaf base, rectangular, 11-15 μ m wide, 3-4 : 1, walls thin to evenly thickened. Propagula unicellular, angular-spherical to elliptical, 11-22(-35) μ m in diameter, borne serially on branching stalks in axils of upper leaves, forming a massive, brown to black mass in the axil.

Dioicous. Perichaetia terminal, inner leaves larger, little different in shape from cauline leaves, to 2.5 mm long, clasping seta, perigonia terminal, sessile on soil, gemmate. Sporophyte seta one per perichaetium, (0.7-)2.0-2.5 cm long, yellow to red-brown, twisted clockwise below, counterclockwise above; theca 1.5-3.0 mm long, red-brown, smooth when dry, cylindrical, neck weakly differentiated; exothelial cells rectangular, 22-25 μ m wide, 3-4 : 1, walls moderately thickened, stomates at base of theca, phaneropore; annulus of 2-3 rows of revolvable, deciduous, vesiculose cells; peristome twisted counterclockwise 2-4 times, of 32 filamentous, orange, densely spiculose teeth, 500-950 μ m long, with many articulations, basal membrane low, 45-85 μ m high, spiculose; operculum long-conic, 0.8-1.3 mm long, cells twisted counterclockwise. Calyptra not seen. Spores light yellow, essentially smooth, 9-11 μ m in diameter. Laminal color reactions (after clearing in conc. lactic acid) : Cl (conc. HCl) : green + medium orange- to yellow-brown; K (10% KOH) : dark red; N (conc. HNO₃) : light red-brown to medium orange-brown; SE (H₂SO₄-ethanol, 2 : 1) : green + dark red. Illustration : Pl. IV, fig. 16-19.

The axillary masses of unicellular propagula easily distinguish this species from other taxa of *Bryoerythrophyllum*, except *B. calcareum*, which has ligulate leaves with thick-walled marginal cells. Unicellular propagula are apparently rare in the Pottiaceae; *Husnotiella revoluta* Card. has similar masses of unicellular propagula in the leaf axils, but is distinguished by the costa with

only one stereid band, the laminal cell walls evenly thickened, and papillae solid, low, broad, simple to multiplex, usually lens-like.

Habitat : soil, rock, walls, 700-3100 m elevation.

Mexican distribution : Chiapas, Mexico, Michoacán.

Range : U.S.A. (North Carolina), Mexico, Panama, Venezuela, Colombia, Ecuador, Canary Islands, Java, China, India.

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ULTRASTRUCTURE OF THE SPOROPHYTE FOOT IN PHAEOCEROS

R. GAMBARDELLA, R. LIGRONE and R. CASTALDO*

SUMMARY. The ultrastructure of the sporophyte foot of *Phaeoceros laevis* (L.) Prosk. subsp. *laevis* Prosk. (Anthocerotopsida) is described. In the foot a central bulbous region, constituted by large vacuolated cells and without intercellular spaces, is surrounded by the placental region. In the latter two deeply intermingled cell types were recognized, the branched haustorial cells and the transfer cells, belonging to the sporophyte and to the gametophyte respectively. This was ascertained on the basis of the plasmodesma distribution and of other ultrastructural features, mainly of the plastids. The two generations are separated in the placental region by an extensive system of intercellular spaces which do not disappear even where the transfer cells and the haustorial cells are closely approached. Peculiar crystal bodies were observed in the intercellular spaces and in transfer cell vacuoles. The unusual organization of the placental region is discussed in relation to the nutrient translocation.

INTRODUCTION

The contact region between the sporophyte and the gametophyte exhibits a distinctive differentiation in the bryophytes. In the mosses and liverworts the two generations are sharply outlined in the placental region (ROSANDER 1906; LORCH 1925a, 1925b, 1931; MOTTE 1928; BLAJKLEY 1933). Transfer cells have been reported on the gametophyte and/or sporophyte side of this region (HEBANT 1977, WIENCKE & SCHULZ 1978).

In the anthocerotes a high degree of histological variability has been recognized as for the overall structure of the mature foot, generation outlines, mucilage layers, and foot and gametophyte cell size differences (CAMPBELL 1918, BARTLETT 1928, PROSKAUER 1951). Today, however, ultrastructural informations on anthocerote foot are not available.

A *Phaeoceros* representative was chosen for the ultrastructural study reported in this paper. Since in this genus the foot and gametophyte cells are closely intermingled in the placental region (RENZAGLIA 1978) the ultrastructural

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observation may provide more precise criteria for ascertaining the relationships between the cells of the two generations.

MATERIAL AND METHODS

Phaeoceros laevis (L.) Prosk. subsp. *laevis* Prosk. grows spontaneously in the Botanical Gardens of the University of Naples. The sporophytes develop from February to May.

Feet of sporophytes about 1 cm emerging from the involucre were isolated with a razor blade together with a small portion of the surrounding gametophyte parenchyme. After careful washing the samples were fixed either with 3% glutaraldehyde in 0.05 M phosphate buffer pH 7 or 2% glutaraldehyde + 1% acrolein in 0.05 M cacodylate buffer pH 7 for 2 hours at room temperature. In both cases the samples were postfixed for 2 hours at room temperature with 2% OsO₄ + 0.7% K₂Cr₂O₇ in the suitable buffers. The samples were then dehydrated in ethanol and propylene oxide and embedded in the SPURR's resin (1969). Ultrathin sections, cut by a diamond knife, were stained with uranyl acetate and lead citrate and observed by a Siemens Elmiskop (A electron microscope).

Sections 2-3 µm thick, obtained by glass knives and stained with 0.1% toluidine bleu, were observed by a Leitz Dialux 20 EB light microscope.

The ultrastructural observations were made at the Centro di Studio di Microscopia Elettronica of the Faculty of Sciences (University of Naples).

RESULTS

Optical observations (Pl. I)

The foot of *P. laevis* is formed by a central bulbous region surrounded by a well developed placental region (fig. 1). The former consists of large vacuolated cells and lacks intercellular spaces. In the latter numerous small cells provided with wall protuberances (transfer cells) are intermingled with oblonged and irregularly branched cells rising from the central region of the foot (fig. 2). These cells are termed haustorial cells, owing to their haustorial-like projections. The placenta is rich in intercellular spaces, whose content is intensely stained with toluidine bleu. Close to the placenta the gametophyte parenchymatous cells show a flattened shape, especially at the bottom of the foot (fig. 1).

Ultrastructural observations (Pl. II-XIV)

Central region

The central region of the foot (Pl. I) is constituted by large parenchymatous cells and, according to the light microscope observations, lacks intercellular spaces. The cells have thin unilayered walls and usually contain one large vacuole and abundant lipid reservoirs. Typically their plastids have an irregular shape, contain many starch granules and a scarcely developed lamellar apparatus and

lack the pyrenoid. Furthermore these plastids often show large membrane-bound cavities filled with a granular content less electron-dense than the stroma (fig. 3). The plastids of the uppermost cells of the central region have a lamellar apparatus more developed than those of the inner and peripheral cells (fig. 4).

Placental region

Transfer cells. — The transfer cells have a polyhedral shape with variable but generally small sizes. Their wall protuberances usually are on the cell sides towards the intercellular spaces (fig. 5, 6, 7, 11). At high magnifications these protuberances appear to be formed by a central electron-dense core surrounded by a sheath of concentrically arranged fibrils (fig. 8). These fray at the periphery and give rise to a loose net occupying a large light area delimited by the plasma membrane (fig. 9). This area extends along all the inner wall surface and is interrupted only at the level of the plasmodesmata (fig. 10).

Typically the transfer cell plastids have an oblonged and irregular shape, do not contain starch granules and show a greatly reduced lamellar apparatus. This is constituted by short thylakoids filled with an electron-dense matrix and arranged in small grana among which several plastoglobules are present. The stroma occupies most of the plastid lumen. No pyrenoid was ever observed in such plastids (fig. 12, 16).

The plastids of the more external transfer cells retain their oblonged shape but show a rather developed lamellar apparatus and sometimes contain starch granules and a small pyrenoid (fig. 14, 15). So they appear more similar to the chloroplasts of the surrounding parenchymatous cells of the gametophyte (fig. 7, 13).

The cytoplasm of the transfer cells contains an abundant reticulum, several dictyosomes and numerous spheroidal mitochondria. The fairly developed vacuolar apparatus is constituted by several extremely irregular vesicles where numerous cytoplasmic digitations penetrate (fig. 6). The nucleus shows an evenly granular nucleoplasm with a small nucleolus and is sometimes associated with rough endoplasmic reticulum (fig. 12).

Haustorial cells. — These are oblonged cells always devoid of wall protuberances and larger than the transfer cells, among which they creep branching out irregularly (fig. 5, 7).

The haustorial cells contain one or few large vacuoles that push the cytoplasm close to the cell walls. Most of their cytoplasm, however, is gathered at the branch extremities (fig. 5, 11). These are rich in mitochondria, dictyosomes and rough endoplasmic reticulum and often appear, in the sections, quite isolated inside the intercellular spaces (fig. 17, 19). The nucleus shows a well developed nucleolus and is often associated with regularly arranged sheets of rough endoplasmic reticulum (fig. 18).

The plastids of the haustorial cells are somewhat similar to those of the central region cells. In fact they have a spheroidal shape, are quite devoid of grana and contain several starch granules. These are apparently bound by one membrane and partly or completely surrounded by thylakoids filled with a dark material (fig. 21, 22). One or more electron-dense areas often can be seen at the

periphery of the plastids (fig. 19, 21). They seem constituted by an irregular network of anastomosed tubular vesicles, by plastoglobules and by a dense granular material that reminds the pyrenoidal matrix (fig. 23). Nevertheless a typical pyrenoid was never seen in such plastids. The stroma has a granular appearance and contains numerous oblonged or spheroidal vesicles apparently rising from the inner membrane of the plastid envelope (fig. 19). Membrane-bound cavities like those of the plastids of the central region cells sometimes were observed in the haustorial cell plastids (fig. 18).

Intercellular spaces. — The intercellular spaces constitute an uninterrupted system of intercommunicating cavities (fig. 5) filled with a loose net of fibrillar material and numerous dense bodies that show a crystalline substructure at high magnifications (fig. 25, 27). The size of these bodies is very variable, ranging from 0.1 μm or less to 1 μm or more. In longisection they appear to be constituted by a number of parallel arranged electron-dense bands about 5 nm thick and separated from one another by light spaces about 6 nm thick (fig. 28, 30). In transection a hexagonal symmetry can be recognized in the arrangement of these bands (fig. 29, 31). Crystal bodies have often been seen also inside transfer cells, where they are within vacuoles (fig. 25, 26).

The intercellular spaces often contain large membrane-bound cavities and numerous other irregularly scattered membranous structures (fig. 24). The haustorial cell walls towards the intercellular spaces are externally covered by a compact fibrillar layer about 50 nm thick separated by a light space 10–15 nm thick (fig. 9). In these regions therefore the haustorial cell walls appear bilayered (fig. 19, 32). The external layer disappears where the haustorial cells are adjoined each other. The transfer cell walls facing the intercellular spaces usually lack such external layer but fray peripherically and give rise to a loose net that mixes with the intercellular material (fig. 9, 32).

Symplastic connections

The presence and distribution of the plasmodesmata were carefully investigated on a great number of sections. Our observations showed that plasmodesmata are present between the haustorial cells and between the transfer cells, but not between the haustorial and the transfer cells. The walls of these two cell types are always separated by intercellular spaces that may reduce greatly but do not disappear even where these cells are tightly approached (fig. 11, 32). An intercellular space also surrounds the projections of the haustorial cells that sometimes come up to the parenchymatous cells of the gametophyte, outside the placenta. In these points the gametophyte cells may appear even more flattened (fig. 5).

On the inner side of the placenta plasmodesmata connect the haustorial cells with the cells of the central region of the foot (fig. 20). On the other hand the transfer cells show symplastic connections with the parenchymatous gametophyte cells, on the external side of the placenta (fig. 6, 7, 11).

DISCUSSION

The constant absence of plasmodesmata and common septa between the haustorial and the transfer cells shows these two cell types belong to different generations. The plasmodesma distribution indicates that the haustorial cells belong to the sporophyte whereas, according to GUNNING & PATE (1969), the transfer cells belong to the gametophyte. This assumption is strengthened by the ultrastructural features of the various cell types. The haustorial and the transfer cells always differ very markedly in their shape, wall, and plastid ultrastructure. Furthermore there are meaningful similarities, as for the plastid ultrastructure, between the haustorial and the central region cells, and the transfer and the surrounding gametophyte cells, respectively. In these two cellular lines two oppositely directed gradients of more and more developed plastids can be recognized, that start from the placental region (fig. 21, 4, 3 and Pl. VII). This also suggests the two generations may exercise a reciprocal influence on the respective morphogenetic potentialities during the foot development.

The number of plastids per cell — another potentially useful criterion for valuating whether a cell of the placental region of *Phaeoceros* is sporophytic or gametophytic (SMITH 1955, BURR 1970) — was not extensively investigated. Nevertheless our sections showed that at the most two plastid profiles are present in the foot cells, only one in the gametophyte parenchymatous cells but one, two or more in the transfer cells. In the last case, however, probably they are profiles of the lobes of a single irregularly shaped plastid. On the other hand the hypothesis that the transfer cells are sporophytic must presuppose, on the basis of our observations, that symplastic connections link the two generations in *Phaeoceros*. This appears quite unlikely especially if the developmental stages of the foot formation from the zygote are considered (CAMPBELL 1918, BARTLETT 1928).

Though in *Phaeoceros* the sporophyte and the gametophyte interpenetrate each other deeply, the two generations remain always separated by the intercellular spaces, that constitute an extensive acellular system between them.

Such organization suggests the sporophyte draws water and nutrients directly from the intercellular spaces through the haustorial cells, whose oblonged shape produces an extensive increase of the absorbing surface of the foot. Likely these substances (THOMAS et al. 1978) are supplied by the transfer cells that pump them from the gametophyte parenchyme. In this respect it is interesting to stress the transfer cell wall protuberances are not constantly localized on a single cell side, as in the mosses and liverworts (HÉBANT 1977), but preferably on the cell sides towards the larger intercellular spaces. This constitutes, together with the presence of transfer cells only on the gametophytic side of the placenta, a quite unusual situation among the bryophytes.

Another peculiarity of the foot of *Phaeoceros* is the presence of dense bodies in the intercellular spaces and in the transfer cells, that have never been reported in the gametophyte-sporophyte interphases of the bryophytes ultrastructurally

investigated up to date (EYMÉ & SUIRE 1967, MAIER 1967, KELLEY 1969, HÉBANT 1975, WIENCKE & SCHULZ 1975, 1978). The crystalline structure of these bodies suggests they are proteinaceous in nature. The presence of crystal bodies inside the transfer cells may indicate these cells as the site of their synthesis. The development of crystal bodies and intercellular spaces, however, could not be recognized in this study. Crystal bodies are also present in the intercellular spaces delimited only by haustorial cells. This leads to believe the fibrillar matrix of the spaces may have a fluid consistence *in vivo*, which allows their diffusion.

The apparent aptitude of the sporophyte of *Phaeoceros* to take up nutrients from an acellular environment might be an example of an intermediate evolutionary stage toward the trophic independence of the sporophytic generation.

Our results provide further confirmation of a phyletic gap between the Anthocerotopsida and the other Bryophyta. Moreover the reported histological variability of the foot in the different anthocerot genera (CAMPBELL 1918, BARTLETT 1928, RENZAGLIA 1978) needs further ultrastructural investigations.

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PLATE LEGENDS

Abbreviations. - CB : crystal body, CR : central region, CRc : central region cell, Dy : dictyosome, EdA : plastid electrondense area, GP : gametophyte parenchyme, GPe : gametophyte parenchymatous cell, Hc : haustorial cell, HcW : haustorial cell wall, Is : intercellular space, LD : lipid droplet, M : mitochondrion, MR : meristematic region, N : nucleus, Nu : nucleolus, P : plastid, Pd : plasmodesma, PR : placental region, Py : pyrenoid, S : starch granule, Tc : transfer cell, TcW : transfer cell wall, V : vacuole, WP : wall protuberance.

Pl. I. - Light microscope. 1 : Overall view of the sporophyte foot of *Phaeoceros* embedded in the gametophyte parenchyme. It is constituted by a central bulbous region surrounded by the placenta. Note the flattened shape of the gametophyte parenchymatous cells at the bottom of the foot (x 165). 2 : Higher magnification of the placenta, constituted by haustorial cells intermingled with transfer cells. The intercellular spaces between them are intensely stained (x 790).

Pl. II. - Central region of the foot. 3 : Peripheral cells, containing one large vacuole and plastids with starch granules and a scarcely developed lamellar apparatus. Large membrane-bound cavities (asterisks) are often present in these plastids (x 1750). 4 : Upper-

most cells. The plastids show a more developed lamellar apparatus ($\times 1750$).

Pl. III. — 5 : Placental region. This is constituted by transfer cells among which the haustorial cells penetrate. Intercellular spaces separate these cells. The gametophyte parenchymatous cells are markedly flattened in the points of contact with haustorial cells ($\times 2250$).

Pl. IV. — Peripheral transfer cells. Note the wall protuberances toward the intercellular spaces. The transfer cell plastids retain a rather developed lamellar apparatus, starch granules (fig. 6, $\times 6000$) and, sometimes, the pyrenoid (fig. 7, $\times 2500$). Plasmodesmata (arrows) connect the transfer cells with each other and with the gametophyte parenchymatous cells.

Pl. V. — Details of transfer and haustorial cell walls. 8 : Transversal section of the wall protuberances in a transfer cell ($\times 25000$). 9 : Comparison between the transfer and the haustorial cell walls. The external surface of the haustorial cell walls towards the intercellular spaces is covered by a thin electrondense layer (arrow) that is absent on the transfer cell walls ($\times 42000$). 10 : High magnification of plasmodesmata between two transfer cells. The light area extending along the inner wall surface is interrupted only at the level of plasmodesmata ($\times 35000$).

Pl. VI — 11 : Relations between transfer and haustorial cells. The cytoplasm of the haustorial cells is mostly gathered at the branch extremities. Large intercellular spaces usually separates the two cell types ($\times 6000$). 12 : Plastid and nucleus of a transfer cell. Several regularly arranged sheets of rough endoplasmic reticulum are associated with the nucleus ($\times 14000$).

Pl. VII. — Gradient of the plastid ultrastructure from the typical gametophyte cells to the inner transfer cells. The progressive reduction of the lamellar apparatus, starch content and pyrenoid, and the increase of the plastoglobules are evident. 13 : Detail of the typical chloroplast of a gametophyte cell ($\times 15000$). 14 : Chloroplast of a gametophyte cell near the placental region ($\times 13000$). 15 : Plastid of a peripheral transfer cell ($\times 39000$). 16 : Plastid of an inner transfer cell, containing few thylakoids filled with a dark material and quite devoid of starch and pyrenoid ($\times 44000$).

Pl. VIII. — 17 : Branches of haustorial cells in transection. They are surrounded by the intercellular spaces ($\times 5000$). 18 : Detail of the above micrograph, showing the nucleus of an haustorial cell provided with a large nucleolus and associated with several regularly arranged sheets of rough endoplasmic reticulum. Note the membrane-bound cavity (asterisk) within the plastid ($\times 17000$).

Pl. IX. — 19 : High magnification of an haustorial cell branch extremity in transection. It is filled with a dense cytoplasm containing numerous mitochondria. The tangentially cut plastid shows an electrondense area rich in plastoglobules, and several small vesicles rising from the inner membrane of the envelope (arrows). The bilayered structure of the wall is evident ($\times 20000$). 20 : Septum between a haustorial cell and a central region cell. It is crossed by several plasmodesmata (arrows) ($\times 12000$).

Pl. X. — 21 : Typical plastid of a haustorial cell. It contains numerous membrane-bound starch granules surrounded by thylakoids filled with a dark material ($\times 25000$). 22 : Detail of a starch granule ($\times 41000$). 23 : High magnification of an electrondense area, apparently constituted by irregularly anastomosed vesicles, numerous plastoglobules and by a dense granular matrix ($\times 81000$).

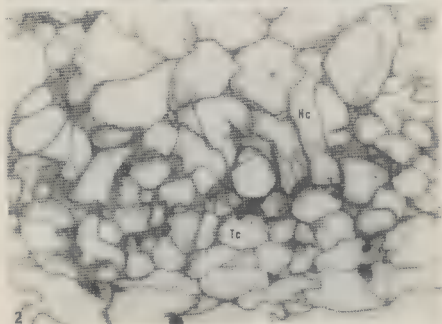
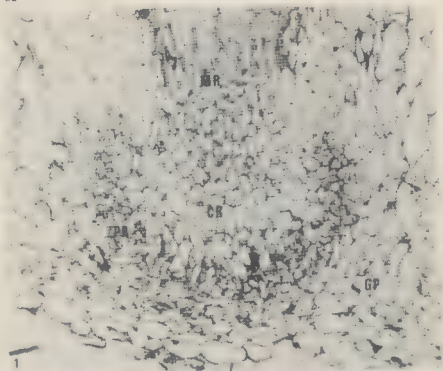
Pl. XI. — 24 : An intercellular space, delimited in the section by three transfer cells. It contains a loose fibrillar matrix, some small crystal bodies and numerous irregularly

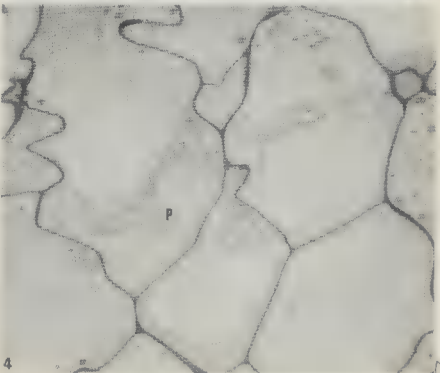
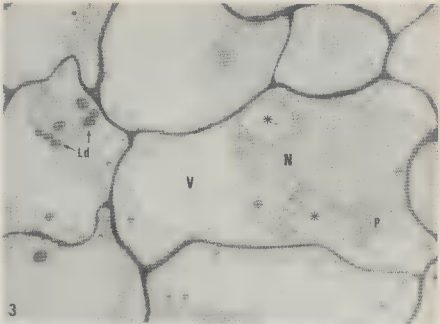
scattered membranous structures ($\times 36000$). 25 : Intravacuolar crystal bodies in a transfer cell ($\times 4500$).

Pl. XII. — 26 : High magnification of two crystal bodies within a transfer cell vacuole. Note their polyhedral shape ($\times 62000$).

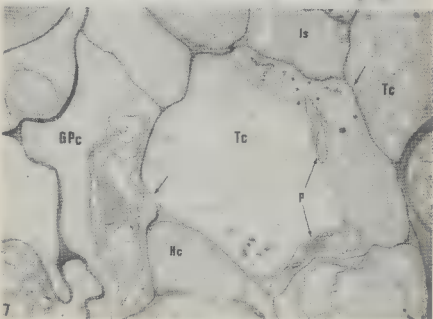
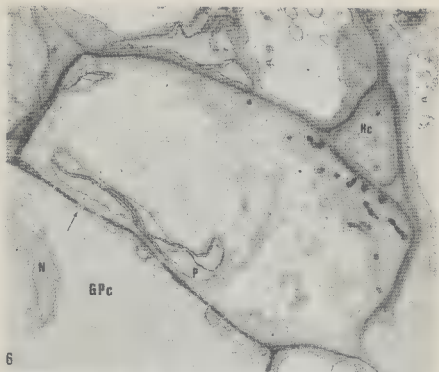
Pl. XIII. — 27 : Intercellular space, filled with numerous crystal bodies which were cut both transversally and longitudinally ($\times 72000$). 28 : High magnification of a crystal body in longitudinal section ($\times 90000$). 29 and 31 : transversal sections of crystal bodies. Note the hexagonal network ($\times 96000$, $\times 163000$). 30 : Detail of fig. 28 ($\times 187000$).

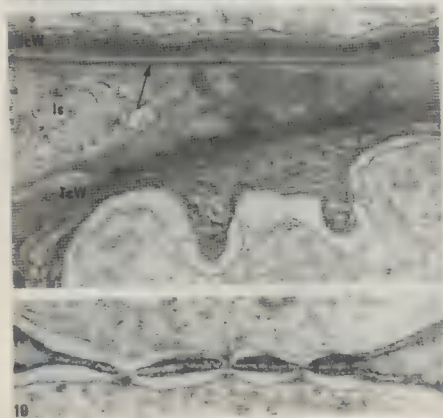
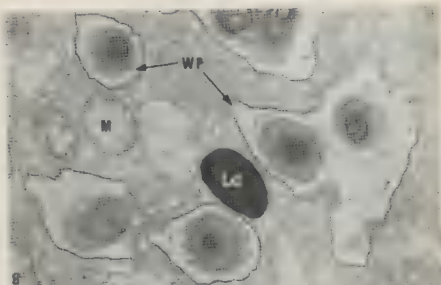
Pl. XIV. — 32 : A haustorial cell closely approached to a transfer cell. An intercellular space remains between them though it is greatly reduced in some points. Note the marked differences in the plastid ultrastructure between the two cell types ($\times 18000$).

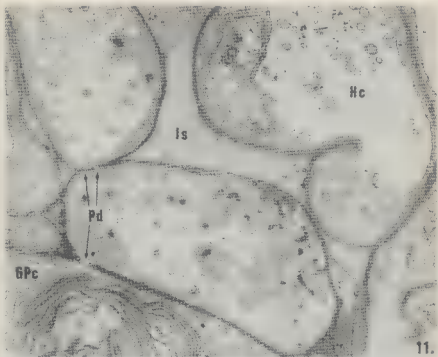


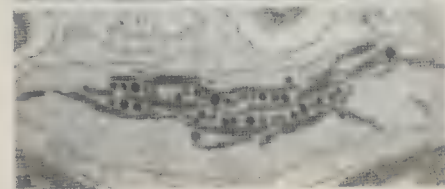
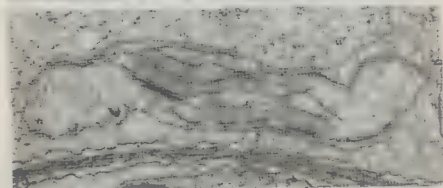
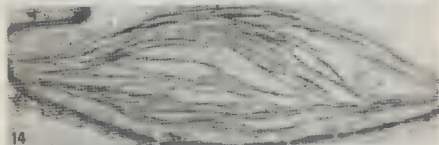
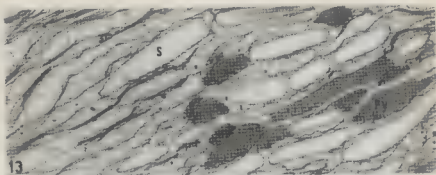


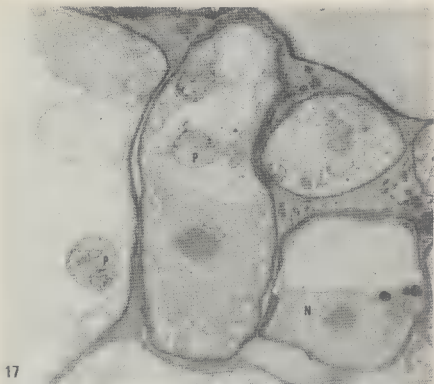




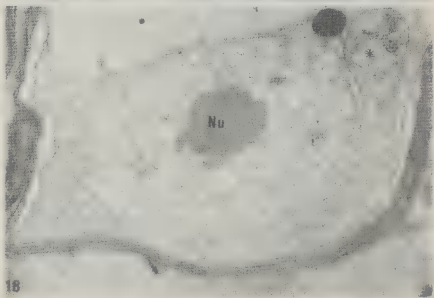






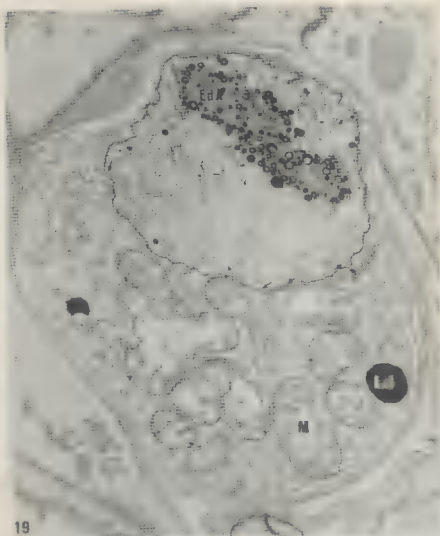


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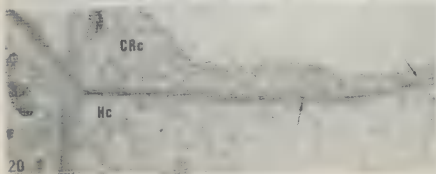


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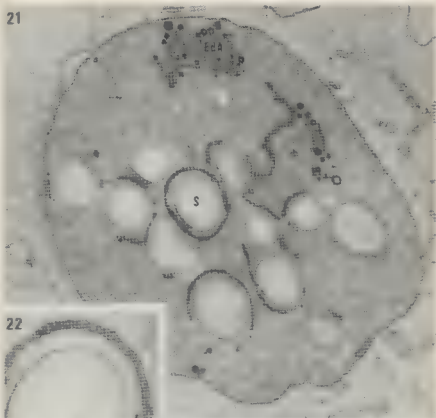


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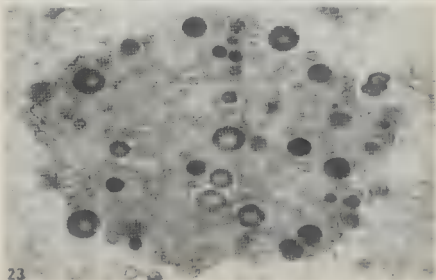
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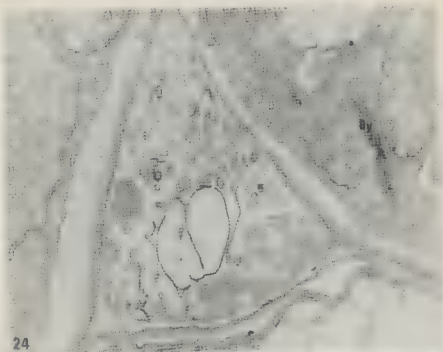


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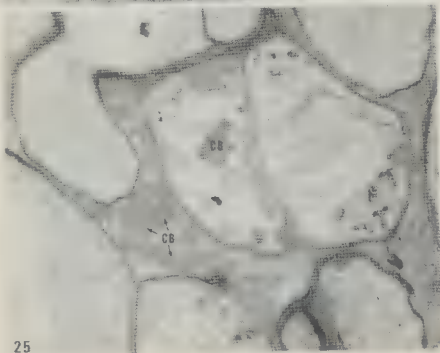


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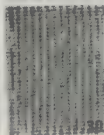
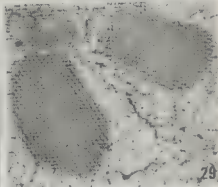
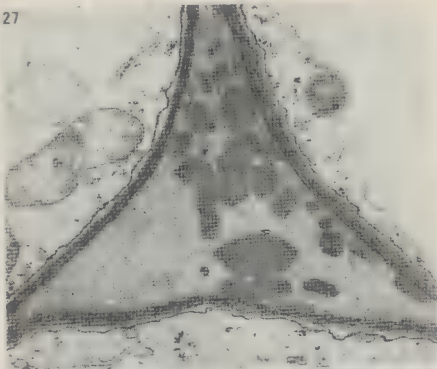
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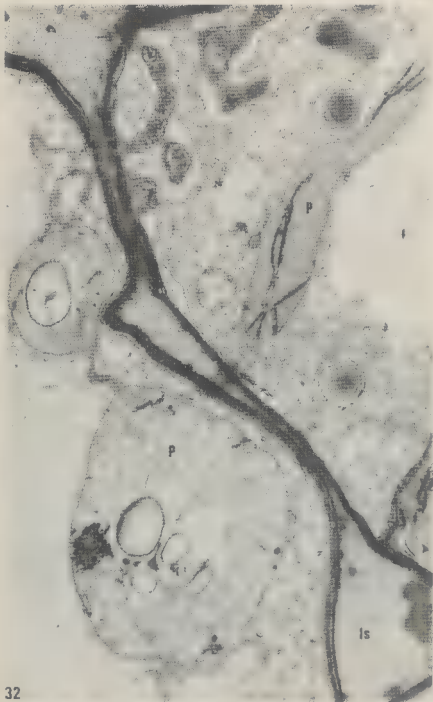


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27





LA NOTION D'ESPECE CHEZ LE GENRE COLOLEJEUNEA

Le complexe *Cololejeunea floccosa* (Lehm. & Lindenb.) Schiffn.

P. TIXIER *

SUMMARY. — The author divides the species *C. floccosa* in eight varieties viz. : *C. floccosa* var. *aurita*, *C. floccosa* var. *amoenoides*, *C. floccosa* var. *floccosa*, *C. floccosa* var. *trivittata*, *C. floccosa* var. *plicata*, *C. floccosa* var. *angustibracteata*, *C. floccosa* var. *ocellata*, *C. floccosa* var. *auriculata*.

Nous étudierons la notion d'espèce à propos du sous-genre *Taeniolejeunea* (Zwick.) Ben. et de son espèce-type : *Cololejeunea floccosa* (Lehm. & Lindenb.) Schiffn. Rappelons que le sous-genre *Taeniolejeunea* est défini par le tissu foliaire à petites cellules papilleuses, par la marge parfois hyaline, par la présence d'une vitta constituée d'ocelles à contenu rouge-orangé.

Dans ce sous-genre, en ce qui concerne la biogéographie, on doit distinguer des espèces et des sections à endémicité plus ou moins élevée, comme nous l'avons écrit en 1968. Cette endémicité semble d'ailleurs être concentrée en Asie du Sud-Est. Ailleurs on ne rencontre guère que des taxons à répartition pantropicale comme *Cololejeunea appressa* (Evans) Ben. *Cololejeunea floccosa* est une espèce à vaste répartition et, en principe, à définition facile. Elle a été décrite en 1832 par LEHMANN & LINDENBERG sous le nom de *Jungermannia floccosa*. Nous reverrons plus loin les tribulations de nomenclature qu'a subi ce taxon. BENEDIX, en 1953, dans son étude consacrée au genre *Cololejeunea*, a tenté de le délimiter sur le plan systématique. Il a décrit trois variétés : *C. floccosa* var. *floccosa*, *C. floccosa* var. *aurita*, *C. floccosa* var. *convivens*. L'aire de distribution des récoltes étudiées était centrée sur la «Malesia» occidentale : Java et Malaisie avec, accessoirement, des récoltes des Célèbes et de Bornéo.

HORIKAWA (1931-1932) et SCHIFFNER (1929) ont signalé l'espèce à Formose et au Japon. CHEN et WU l'ont isolée (1964) en Chine méridionale.

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MIZUTANI (1965) l'inclut dans les florules épiphylls du Sabah (Nord Bornéo). Enfin JONES (1968) l'a trouvée dans du matériel provenant de Sierra Leone, en Afrique de l'Ouest. Nous l'avons personnellement récoltée, au Bangladesh (1965), en Thaïlande (1965), au Laos (1968), au Cambodge (1967-1970), au Vietnam (1958-1963), aux Philippines (1965), à Java (1969-1970), en Malaisie (1969-1972) et à Madagascar (1976-1978). Nous avons disposé, en plus, de récoltes diverses : Humbert et Saboureaux de Madagascar, Tirvengadam et Kostermans de Ceylan, des récoltes néo-calédoniennes de Huerlimann, Schmid et Mac Kee, du matériel japonais de Hattori et de l'herbier d'Hiroshima (HIRO). Nous débiterons, comme dans nos articles précédents, par une énumération du matériel examiné. Le signe (*) indique qu'il ne sera pas analysé dans le texte.

MATÉRIEL EXAMINÉ

Bangladesh : Kaptai, épiphyll en forêt, 50 m, 21.2.1965, Tixier 122, 123.

Cambodge : Koh Cong, Kirirom, 700 m, épiphyll en forêt, 18.4.1967, Tixier 2494 - idem, Peach Nil, 120 m, épiphyll en forêt, 20.5.1967, Tixier 2383 (*) - idem, Sré Ambel, 20 m, épiphyll en forêt dégradée, 19.4.1968, Tixier 3712 - Kampot, Mt Bokor, piste de Kamchay, épiphyll en forêt, 900 m, 18.11.1967, Tixier 2767 (*) - idem, 29.3.1968, Tixier 3522, 3523, 3524, 3525, 3526, 3527, 3528 - idem, 1969, Tixier 4293, 4544.

Ceylan : Southern Province, Galle district, Hiniduma Kande, 400 m, épiphyll sur *Litsea longifolia*, 6.10.1971, Tirvengadam & Kostermans 620 (a, b), 650 - idem, Kennelyia forest, clairière en basse région, 7.10.1971, Tirvengadam 681.

Japon : Riou Kiou, Okinawa, Hanjéi, sur fougères, 25.6.1961, Kora s.n. - Kiou Siou, Kumamoto Pref., Kuma-gum, Ichibu, 11.60, Mayebara 2691 - Hondo, Hyogo Pref., Kato-gum, Yaschiro Sho, base de tronc, 150 m, 1.3.1964, Kodama 23681 - Mt Ishushima, ex hb. Schiffner Hondo, Aki prov., Mt Misen, île Miyajima, 23.4.1931, Horikawa, HIRO 3378 idem, 20.9.1931, Iwamasa, HIRO 5496 - idem, Iwasama 1025, HIRO 5489 - Shikoku, prov. Tosa, Honokawa-yama, Yoshigana 6, HIRO 5519 - Kiou Siou, prov. Higo, Mt Ichibara, 22.3.1933, K. Mayebara, HIRO 10869 - Riou Kiou, Okinawa, Haneji, sur fougères, 21.5.1931, Kora s.n. - idem, Okinawa, Mt Gengadaké, 30.3.1931, Maki, HIRO 3601 - idem, Okinawa, Mt Benoki, 28.3.1934, Horikawa, HIRO 13178 - idem, Okinawa, Mt Yonaha, 27.7.1933, Tamura, HIRO 12218 - Riou Kiou, île Iriomoté, Mt Sonaidaké, 6.4.1934, Horikawa, HIRO 13433 - idem, Mt Fedov, 3.4.1934, Horikawa, HIRO 13362 - Riou Kiou, île Ishigaki, Mt Bannadaké, 31.3.1934, Horikawa, HIRO 13281 - Formose, Prov. de Taihoku, Urai, 7.1928, Noguchi, HIRO 6202 - Botel Tobago, 17.6.1934, Fukuyama & Suzuki, HIRO 14498.

Java : Tjibodas, 1400 m, épiphyll en forêt, 15.4.1969, Tixier 4164, 4349.

Laos : Paksé, Paksong, 1100 m, épiphyll en forêt inondable, 30.12.1968, Tixier 4156, 4159, 4161.

Madagascar : Diégo-Suarez, massif du Marojejy, Ouest d'Andapa, Haute Ambatorahana, bassin inférieur de la Antasakaberoka, 1000 m, 9.11.1959, Humbert & Saboureaux s.n. — Tananarive, Ambatoloana, reste de la forêt primaire, 1250 m, 18.5.1976, Tixier 8347 — Tamatave, Ivaloina, 100 m, 17.2.1977, Tixier s.n.

Malaisie : Kedah, Kedah Peak, 800 m, épiphyllé en forêt, 13.4.1972, Tixier 5965, 5967, 5971 — Pérak, Maxwell's Hill, 900 m, épiphyllé en forêt, 17.4.1972, Tixier 6128, 6136 — idem, 1100 m, épiphyllé en forêt sous falaise, 18.4.1972, Tixier 6154, 6153, 6156 — Pulau Pinang, Penang Hill, 700 m, bas fond à *Cyathea*, 13.4.1971, Tixier 5544, 5545, 5546, 5547, 5549, 5551, 5552, 5586, 5590 — Sélangor, Fraser's Hill, 1300 m, épiphyllé en forêt, 26.12.1969, Tixier 4688 — Johore, Mt Ophir, 300 m, épiphyllé en forêt secondaire au bord du lac, 20.4.1972, Tixier 6246.

Nouvelle-Calédonie : Dumbéa, vallée de la Sunshine, vers le Mt To, 700 m, 27.7.1951, Huerlimann 2748 — Haute Yaté, Rivière Bleue, épiphyllé en forêt, 16.6.1974, Schmid s.n. — Rivière Thi, épiphyllé en forêt, 11.1974, Schmid s.n. — Poindimié, Povila, 400 m, forêt humide sur schistes, épiphyllé sur *Freyinetia*, 26.9.1977, Mac Kee 33858 pp — Base du col de Negacia, versant de Camboui, 150 m, s.d., Veillon s.n. — Touho, Ponandou, forêt galerie, sur schistes, 30 m, épiphyllé sur *Psychotria* sp., 22.3.1975, Mac Kee 29906.

Nouvelle-Guinée : Bismarck Gebirge, 30 m, 18.10.1899, Lauterbach 3115a (ex hb Stephani 19123).

Philippines : Luçon, Laguna, Mt Maquiling, épiphyllé en forêt, 1000 m, 20.5.1965, Tixier 1194 — idem, Sorzogon, ex hb Lindenberg 6180 (ex hb Stephani 19121) (isotype).

Thaïlande : Nakhon Ratchasima, Khao Yai, épiphyllé en forêt galerie, 700 m, 20.3.1965, Tixier 1194 (*) — Surat Thani, Thanom Phrao, 40 m, épiphyllé en forêt dense, 18.4.1965, Tixier 677, 678.

Vietnam : Khanh Hoa, Suoi Lau, 100 m, 30.10.1959, Tixier s.n. — Lam Dong, Bao Lôc, 700 m, 20.3.1958, Tixier s.n. — idem, 18.11.1959 (a, b, c), Tixier s.n. — idem, 3.12.1959, Tixier 2278 — idem, épiphyllé en forêt, 14.1.1960, Tixier s.n. — idem, forêt du pk 184, 2.1.1960, Tixier s.n. — idem, 10.1.1960, Tixier s.n. — idem, derrière l'Ecole d'Agriculture, 11.1.1960, Tixier s.n. — idem, 21.1.1960, Tixier s.n. — idem, piste forestière de la Dalao, 11.11.1960 et 22.3.1961, Tixier s.n. — idem, Da Brinh, 700 m, 30.11.1960, Tixier s.n. — idem, Bao Lôc, 700 m, en forêt dense, 1.6.1961, Tixier s.n. — idem, Santa Maria, 150 m, 17.1.1961, Tixier s.n. — idem, Col des Bananiers, 120 m, 3.3.1961, Tixier s.n. — idem, Klong Riôt, 600 m, épiphyllé en forêt galerie, 10.3.1961, Tixier s.n. — Tuyên Duc, Dalat, station forestière de Manline, épiphyllé en forêt, 20.1.1958, Tixier s.n. — idem, Dalat, Mt Lang Bian, 1900 m, épiphyllé en forêt, 1958, Tixier s.n. — Long Khanh, Dinh Quân, pk 128 de la route Saïgon-Dalat, 100 m, 3.3.1962, Tixier s.n. — Ninh Binh, parc de Cuc Phuong, épiphyllé en forêt, 20.11.1965, Pocs, Tran Ninh et Bich 3049/3.

En faisant abstraction du nombre exact de récoltes, nous avons examiné

du matériel provenant d'une soixantaine de localités et revu la plupart du matériel des grands herbiers. Signalons cependant que l'herbier Stephani contient sept échantillons sous le binôme *Cololejeunea floccosa*. Seuls les numéros 19121 et 19123 font partie du complexe, 19122 et 19123 appartiennent au complexe *Cololejeunea mutabilis* Ben., 19124 et 19126 contiennent *Cololejeunea appressa* (Evans) Ben., et 14342 est un taxon proche de *Cololejeunea bontocensis* P. Tx.

DESCRIPTION BIBLIOGRAPHIQUE DE L'ESPECE

Dans la bibliographie l'espèce est définie de façon taxonomique et iconographique comme suit :

Cololejeunea floccosa (Lehm. & Lindenb.) Schiffn., Conspect. Hep. Archip. Ind. : 243, 1898.

Synonymes : *Jungermannia floccosa* Lehm. & Lindenb. in Lehm., Pugillus 5 : 26, 1832.

Lejeunea floccosa (Lehm. et Lindenb.) Lehm. et Lindenb. in Gott., Lindenb. et Nees, Syn. Hep. : 324, 1845.

Symbiezidium floccosum (Lehm. et Lindenb.) Trev., Mem. Ist. Lombardo, ser. 3, 4 : 403, 1877.

Leptocolea floccosa (Lehm. et Lindenb.) Steph., Sp. Hep. 5 : 850, 1916.

Taeniolejeunea floccosa (Lehm. et Lindenb.) Zwick., Ann. Bryol. 6 : 107, 1935.

Icones : BENEDIX, *Feddes Rep.* 134, tab. 4, a-d, 1953 — CHEN & WU, *Acta Phytotax. Sin.* 9 (3) : 247, fig. 15, 1-8, 1963 — MIZUTANI, *J. Hattori Bot. Lab.* 24 : 275, fig. 37, 20-29, 1961 — JONES, *Trans. Brit. Bryol. Soc.* 3 (3) : 37, fig. 5, a-b, 1968 — IWATSUKI & MIZUTANI, *Bryophytes of Japan* : 351, fig. 181, 1972. On peut remarquer, au passage, que cette espèce proménée de genre en genre, décrite en 1832, n'a été dessinée qu'en 1953 !!!

MORPHOLOGIE ET CARACTERES DE L'ESPECE

Nous donnons ici une description succincte et générale du taxon : plante petite, à l'état sec blanchâtre (d'où le nom), épiphyllé, appliquée au support. Cellules marginales petites, carrées, papilleuses. Cellules basales plus allongées. Vitta d'au moins quatre cellules. Lobe arrondi, dissymétrique ne recouvrant pas la tige, avec ou sans sinus entre la carène et la marge inférieure du lobe. Lobule en sac, dent apicale généralement nulle, dent médiane composée d'une cellule ronde et d'une cellule allongée plus ou moins en crochet. Nous ne pensons pas que le type soit fructifié. Nous reviendrons sur la morphologie du périanthe. Plante monoïque ou synoïque. Propagules presque toujours à 16 cellules. L'espèce appartient à la section *Floccosae* Ben. Elle est définie par la forme de la feuille, la forme de la dent médiane et la longueur de la vitta.

La vitta demeure une caractéristique du sous-genre *Taeniolejeunea* (Zwick.)

Ben., mais on la retrouve chez certaines sections du sous-genre *Lasiolejeunea* Ben. Nous avons décrit une vitta à 1-3 cellules chez *Cololejeunea schmidtii* Steph. (TIXIER 1977). On la rencontre aussi chez *Cololejeunea preciosa* Ben., ces deux espèces appartenant respectivement aux sect. *Globigerae* et *Venustae* du sous-genre *Lasiolejeunea* Ben. La vitta de *C. floccosa* reste proche des vitta de *C. amoena*, de *C. appressa* et de *C. gynophthalma*. Elle se différencie de celles de *C. mutabilis* Ben. et *C. falcata* (Horik.) Ben. par sa moindre largeur.

Le sinus de la base du lobe, entre la carène et la marge inférieure du lobe, est nul ou faible ce qui sépare *C. floccosa* de *C. mutabilis*, *C. appressa*, *C. gynophthalma* et *C. falcata*. Nous avons décrit, de Malaisie, *C. mutabilis* fo. *floccosoides* qui diffère de *C. floccosa* par la largeur de sa vitta.

L'organisation de la dent médiane éloigne *C. floccosa* de *C. appressa*, de *C. gynophthalma* et de *C. falcata* où l'apex du lobule est organisé de façon différente. Cette même morphologie la rapproche de *C. amoena* (espèce à sinus entre marge et carène marqué) et de *C. tenella* (sect. *Globigerae* du sous-genre *Lasiolejeunea*) qui ont la même organisation de l'apex du lobule mais un tissu cellulaire différent, à grosses papilles, avec ou sans vitta. Enfin *C. mutabilis* et ses différentes formes possèdent une dent médiane proche de celle de *C. floccosa* mais cette dent est généralement obtuse.

Nous voyons que les sections *Floccosae* et *Falcatae* du sous-genre *Taeniolejeunea* et *Globigerae* du sous-genre *Lasiolejeunea* (au moins au niveau de certaines espèces) forment un tout continu.

Nous allons examiner les caractères suivants :

Morphologie de la feuille : 1 - forme, 2 - taille, 3 - distance entre les feuilles, 4 - rapport longueur du lobule/longueur de lobe.

Tissu foliaire : 5 - cellules marginales, 6 - longueur de la vitta, 7 - largeur de la vitta, 8 - ornementation des ocelles, 9 - organisation de l'apex du lobule, 10 - propagules.

Périanthe : 11 - rapport entre la longueur du périanthe et la longueur des bractées, 12 - morphologie de l'apex du lobule des bractées périnthaires, 13 - présence ou absence d'oreillettes, 14 - plis ventraux, 15 - présence d'ocelles sur le périanthe, 16 - forme du périanthe, 17 - épi mâle.

Nous allons reprendre les différents caractères selon l'ordre indiqué. La végétation du genre *Cololejeunea* est assez connue. Les tiges immatures demeurent généralement peu ramifiées; les ramifications proviennent de l'apparition des périanthes sous lesquels naissent les innovations sympodiales. La protandrie est souvent de mise surtout dans le sous-genre *Pediolejeunea* (Ben.) Mizutani. Elle est parfois très précoce, puisque les bractées mâles fertiles apparaissent dès le troisième étage de feuilles sur le rameau issu du propagule. Chez certaines espèces, il existe un polymorphisme lié à la sexualité, les rameaux juvéniles étant entièrement constitués de feuilles bractéales mâles (cf. *Cololejeunea abnormis* Mizutani). Par ailleurs, dans le sous-genre *Lasiolejeunea*, la fructification mâle et la fructification femelle apparaissent la plupart du temps à l'extrémité de rameaux secondaires.

1 — Forme des feuilles. En principe les feuilles de *Cololejeunea floccosa* sont elliptiques avec une légère dissymétrie et sans sinus entre la carène du lobule et la marge inférieure du lobe. BENEDIX (1953), dans sa clé, sépare les *Floccosae* des *Falcatae* par l'existence d'un sinus chez les espèces de la seconde section. Dans un certain nombre de taxons, ceux à longue vitta spécialement, on trouverait une légère inversion entre la courbe de la carène et la courbe de la marge inférieure de la feuille. Les caractères concernant les sinus ne sont pas absolument constants, pas plus d'ailleurs que la forme de la feuille qui passe parfois à une forme subtriangulaire.

2 — Taille des feuilles. Nous avons déjà expliqué que la taille des Lejeunéacées épiphylls est d'un médiocre intérêt taxonomique. On peut, en effet, rencontrer des « formes miniatures » des taxons typiques sans que l'on puisse en tirer des conclusions d'ordre systématique. La longueur du lobe varie entre 0,5 mm et 0,2 mm. Notons cependant que les échantillons japonais et néo-calédoniens, qui correspondent aux limites de la distribution, ont des lobes généralement plus petits (0,3 mm).

3 — Distance entre les feuilles. Elle est généralement de 0,2 mm (mesurée de carène à carène ou de style à style). Ce caractère, d'une façon générale, est très constant chez les « *Paradoxae* » et présente un intérêt taxonomique certain.

■ — **Cellules marginales.** Elles sont petites, généralement isodiamétriques et plus ou moins papilleuses. Les papilles apparaissent, en effet, plus ou moins loin de la marge (jusqu'à trois rangs de la marge). Quelques échantillons ont aussi, réparties plus ou moins groupées le long de la marge, des cellules rectangulaires plus longues qui représentent une amorce vers l'organisation d'une marge semi-hyaline. Nous n'insisterons pas sur la distinction se rapportant à la grosseur des papilles, ni sur le fait que les papilles se rencontrent plus ou moins bas le long de la vitta.

5 — Longueur de la vitta. La vitta se compose d'ocelles plus ou moins remplis, non pas comme chez la plupart des Lejeunéacées d'un ou de plusieurs globules d'essence, mais par une sorte de dépôt de couleur plus ou moins orangée à la loupe binoculaire ou au microscope, les ocelles n'ayant peut-être pas la même signification chimique chez tous les genres (nos observations ont toujours porté sur du matériel frais ou quasiment frais). La vitta est rectiligne quand elle est courte, plus ou moins sigmoïde quand elle s'allonge. Sa longueur s'étage de 4 cellules et de 130-160 μ m à 7-8 cellules et jusqu'à 420 μ m. Nous avons, arbitrairement délimité trois classes : a - 4 cellules, longue jusqu'à 190 μ m; b - 5-7 cellules, longue jusqu'à 220 à 300 μ m; c - 7-8 cellules, longue de plus de 300 μ m. Cette division quelque peu arbitraire se complète par l'étude de la largeur de la vitta (tab. 1).

6 — Largeur de la vitta. BENEDIX (1953) distingue une variété à vitta longue et à une série unique d'ocelles : *Cololejeunea floccosa* var. *floccosa*; une variété à vitta courte et à un rang d'ocelles : *Cololejeunea floccosa* var. *aurita*; et enfin une variété à vitta composée de 2-3 rangs d'ocelles : *Cololejeunea floccosa* var. *convivens*, sans indication précise de la longueur de la vitta. N'ayant pu voir le

Nombre

Longueur de la vitta
en μm

d' OCELLES	4	5	6	7	8
110 - 130	2				
130 - 150	4				
150 - 170	3	1			
170 - 190	1				
190 - 210	2		3		
210 - 230		1	2	1	
230 - 250			3		
250 - 270			1	3	
270 - 290		1		1	
290 - 310		1		2	1
310 - 330					
330 - 350				2	2

Tab. 1. — Longueur de la vitta.

type de la var. *conivens*, la définition de cette variété nous laisse perplexe. Le type de l'espèce, provenant de Luçon (Philippines), possède une vitta courte, à 4 cellules et à deux rangs d'ocelles (ou un rang d'ocelles et un rang de cellules compagnes). Par conséquent, *C. floccosa* var. *conivens* semble être la variété se rapprochant le plus du type. Malgré l'abondance de notre matériel, nous n'avons jamais observé un taxon à vitta longue et sigmoïde à un seul rang d'ocelles.

Généralement, la classe «a» ne possède qu'un rang d'ocelles (*C. floccosa* var. *aurita*) mais parfois (Luçon, Riou Kiou), elle a deux rangs d'ocelles. Les classes «b» et «c» possèdent 2-3 rangs d'ocelles ou plutôt un rang d'ocelles et 1 ou 2 rangs de cellules compagnes qui sont généralement plus étroites que les ocelles s. str.

7 — Parois des cellules de la vitta. Elles peuvent être minces ou munies de trigones et d'épaississements intermédiaires. La classe «a» possède des parois minces, les classes «b» et «c» des parois à trigones. Les caractères «longueur de la vitta», «doublement du nombre des rangs» et «épaisseur des parois» semblent liés.

8 — Apex du lobule. La dent apicale est presque toujours pratiquement nulle. La papille hyaline, plus ou moins piriforme, est externe et située au-dessus de la dent médiane. Celle-ci est généralement composée d'une cellule basale globuleuse et d'une cellule apicale. Cette dernière est d'habitude allongée, parfois arquée, assez rarement courte. BENEDIX a doté, dans son dessin, *C. floccosa* d'une dent apicale de trois cellules. Nous reviendrons plus loin sur ce fait, assez rarement observé.

9 — Propagules. Nous savons que le nombre de cellules des propagules est assez constant, surtout quand il est peu élevé, et nous avons montré que dans la section *Leonidentés* il existait une corrélation positive entre le nombre de cellules du propagule et la longueur de la vitta. Le nombre de cellules du propagule demeure un caractère complémentaire et ne peut, à lui seul, différencier une espèce. Le propagule de *C. floccosa* apporte peu de renseignements intéressants. On le rencontre assez rarement : 22 fois sur 69 échantillons examinés. Il est composé de 16 cellules dont trois cellules «crampons».

10 — Rapport entre la longueur des bractées périnthaires et ■ hauteur du périnthe. Cette caractéristique morphologique est à retenir sur le plan systématique. Nous distinguerons ici deux types d'organisation :

- le périnthe dépasse largement les bractées,
- le haut du périnthe est tangent au sommet des bractées, ou même sous les bractées.

11 — Morphologie du lobule de la bractée périnthere. Les lobules sont généralement larges et arrondis. Dans une seule de nos variétés, ils se présentent en bandelettes. Il est à regretter que la plupart des auteurs s'intéressant aux Lejeunéacées se préoccupent assez peu de la morphologie des bractées périnthaires et de l'organisation de l'apex du lobule. Nous avons séparé *C. vidualiana* de *C. punctata* et des taxons proches par la morphologie du style de la bractée périnthere. Dans le genre *Diplasirolejeunea*, au niveau du groupe des *Comutae* (TIXIER 1977), le haut du lobule de la bractée fournit des données intéressantes. Dans notre étude de la section *Leonidentés* (TIXIER 1968), nous avons observé des différences dans la morphologie de l'apex de la bractée périnthere. Nous avons, avec la restriction que les périnthaires sont, hélas, peu nombreux dans les populations de *C. floccosa*, deux types de lobule : haut du lobule denticulé, — haut du lobule non denticulé.

12 — Présence d'oreillettes. Les oreillettes du haut du périanthe sont fréquentes dans certaines sections du sous-genre *Lasiolejeunea*, mais généralement moins marquées dans le sous-genre *Taeniolejeunea*. Ici seuls les taxons à longue vitta peuvent être pourvus d'oreillettes.

13 — Existence d'une aile ventrale. On trouve cette aile ventrale formée par la confusion des plis ventraux sur les variétés *plicata* et *ocellata*.

14 — Existence de vitta = le périanthe. BENEDIX a décrit des ocelles, ou plutôt des vitta, sur le périanthe de *Cololejeunea gynophthalma*. Nous avons rencontré cette caractéristique anatomique sur quatre des taxons à longue vitta (classe c).

15 — Forme du périanthe. On note des formes en toupie et des formes en cœur, selon la configuration de l'apex du périanthe.

16 — Inflorescence mâle. Bien que ce groupe de taxons soit monoïque ou même synoïque, l'inflorescence mâle se rencontre rarement (6 fois sur 69 échantillons). Elle forme généralement un épi latéral, avec peu d'étages de bractées fertiles (2 ou 3).

CLÉ DES VARIÉTÉS ET DESCRIPTION

Vitta courte, de 4 cellules, mesurant jusqu'à 190 μ m (a)

Papilles petites (1-2 μ m)

1 *Cololejeunea floccosa* var. *aurita*

Papilles grosses (3-5 μ m)

2 *Cololejeunea floccosa* var. *amoenoides*

Vitta moyenne, de 5-7 cellules, mesurant jusqu'à 220-300 μ m (b)

Péríanthe sans aile ventrale

Vitta à deux rangs d'ocelles 3 *Cololejeunea floccosa* var. *floccosa*

Vitta à trois rangs d'ocelles 4 *Cololejeunea floccosa* var. *trivittata*

Péríanthe à aile ventrale 5 *Cololejeunea floccosa* var. *plicata*

Vitta longue, de 7-8 cellules, mesurant plus de 300 μ m (c)

Lobule des bractées péríanthaires étroit

6 *Cololejeunea floccosa* var. *angustibracteata*

Lobule des bractées péríanthaires large

Péríanthe à aile ventrale 7 *Cololejeunea floccosa* var. *ocellata*

Péríanthe à oreillettes 8 *Cololejeunea floccosa* var. *auriculata*

1 — COLOLEJEUNEA FLOCCOSA (Lehm. et Lindenb.) Schiffl. var. AURITA
Ben. Feddes Rep. 134 : 24, 1953. (Fig. 1-3).

Description. — Plante petite, épiphyllé, appliquée au support. Tiges plus ou moins ramifiées; feuilles insérées sous un angle de 70° et distantes entre elles de 0,1 à 0,2 mm. Lobe foliaire ovale à réniforme, de 0,25 à 0,4 mm de long; lobule petit, discoïde, le rapport de la longueur du lobule à celle du lobe variant de 1/3 à 1/4. Lobule parfois réduit (échantillon laotien); léger sinus entre la carène et la marge inférieure du lobe. Cellules de la marge isodiamétriques, de 7 μ m de diamètre. Le tissu papilleux descend pratiquement jusqu'à la moitié de la vitta. Extrémité de la carène parfois crénelée. Vitta à 4 ocelles, longue de

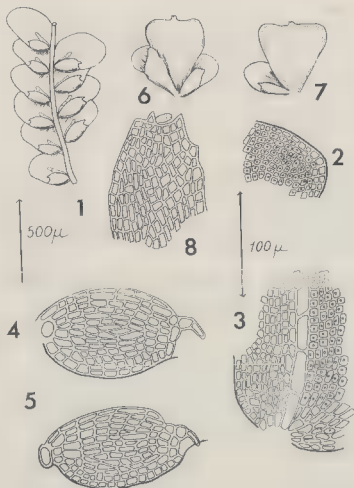


Fig. 1. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *aurita* Ben. (Ceylan 630).
1 : tige. 2 : apex du lobe. 3 : vitta. 4-5 : lobule. 6-7 : périanthe. 8 : apex de lobule périanthaire.

140 à 200 μm. Dent apicale nulle; dent médiane à cellule terminale longue, atteignant parfois le bord du lobe. Bractées périanthaires plus courtes que le périanthe, à lobule peu ou pas denticulé au sommet. Périanthe en toupie; bec peu apparent et à sommet plan (ce dernier point n'est pas conforme à la description de BENEDIX).

Échantillons examinés. - CAMBODGE : Koh Kong, Sré Ambel, épiphyllé en forêt dégradée, 20 m, 19.4.1968, Tixier 3712 (lobule de bractée périanthaire à apex denticulé) - Kampot, Mont Bokor, piste de Kamchay, 900 m, 29.3.1968,

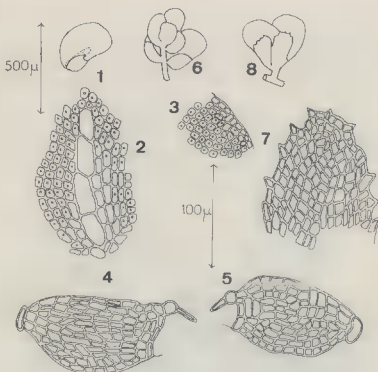


Fig. 2. *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *aurita* Ben. (Srè Ambel 3712). 1 : feuille. 2 : vitta. 3 : apex du lobe. 4-5 : lobules. 6 : épi mâle. 7 : apex du lobule de bractée périnthaire. 8 : bractées périnthaires.

Tixier 3522.

CEYLAN : Galle District, Hiniduma Kande, Tirvengadam et Kostermans 630 (a).

JAPON : Mt Ishukushima ex hb Schiffner - Hondo, Hyogo Pref., Kato-gum, Yashiro Sho, corticole, 150 m, 1.3.1964, Kodama 23681 - Riou Kiou, Okinawa, Mt Yonata, 27.7.1933, Tamura, HIRO 12218 - Kiou Siou, Kumamoto Pref., Kuma-gum, Ichibu, 11.1960, Mayebara 2691 - Riou Kiou, Okinawa, Mt Gengadaké, 30.3.1931, Maki 3601 - Riou Kiou, Okinawa, Mt Yonaha, 22.3.1933, Mayebara, HIRO 10869 - Kiou Siou, île Iriomoté, Mt Fedov, 3.4.1934, Horikawa, HIRO 13362.

LAOS : Paksé, Paksong, épiphyllé en forêt inondable, 30.12.1968, Tixier 4122.

MALAISIE : Kedah, Kedah Peak, 800 m, 13.4.1972, Tixier 5965, 5967, 5971.

THAÏLANDE : Surat Thani, Thanom Phrao, 40 m, épiphyllé en forêt, 18.5.1965: Tixier 677.

VIETNAM : Lam Dong, Bao Lûc, forêt du km 184, 700 m, 2.1.1960 (a), Tixier s.n. – idem, 19.2.1960, Tixier s.n.

Une dent médiane à extrémité composée de deux cellules s'observe assez fréquemment chez des échantillons japonais. Cependant, ce caractère n'est en liaison avec aucun autre caractère, en particulier de la vitta. On ne peut donc

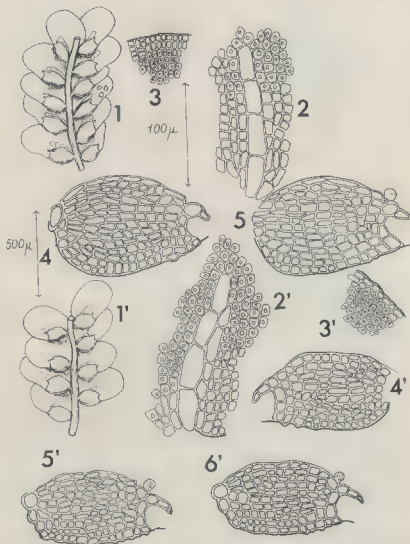


Fig. 3. *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *aurita* Ben. (Hondo). 1 : tige. 2 : vitta. 3 : apex du lobe. 4-5 : lobules. (Kiou Siou). 1' : tige. 2' : vitta. 3' : apex du lobule. 4'-6' : lobules.

guère en tenir compte au point de vue taxonomique, bien que BENEDIX y ait attaché une grande importance en ce qui concerne le complexe *mutabilis* (fig. 3).

2 - *COLOLEJEUNEA FLOCCOSA* (Lehm. & Lindenb.) Schiffn. var. *AMOENOIDES* P. Tx. var. nov. (fig. 4).

Nous avons des doutes sur la valeur réelle de l'espèce *C. amoena* Ben. Notre matériel vietnamien ne se différencie pas essentiellement des taxons qui lui sont sympatrides sauf pour l'agencement de la vitta (caractère mal précisé par BENEDIX pour *C. amoena*), à cellules un peu plus grandes dans le haut, et pour les papilles, plus grosses. Les caractères représentés dans les dessins de BENEDIX :

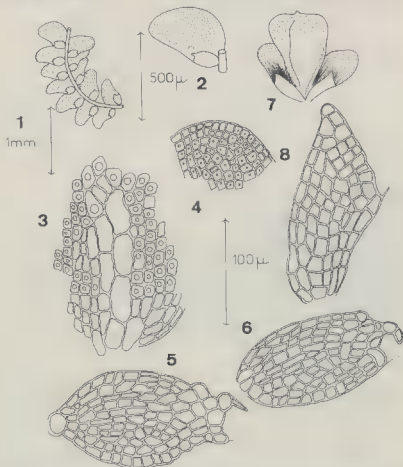


Fig. 4. — *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *amoenoides* P. Tx. (Bao Lôc, 3.10.1961). 1 : tige. 2 : feuille. 3 : vitta. 4 : apex du lobe. 5-6 : lobules. 7 : périanthe. 8 : apex de bractée périanthaire.

sinus entre carène du lobule et marge inférieure de la feuille, densité des papilles sur la carène, forme de l'inflorescence femelle, ne se retrouvent pas sur le matériel vietnamien. Nous avons signalé, pour les *Taeniolejeunea* malaisiens, combien dans certains cas la séparation de *C. floccosa* et de *C. tenella* était difficile.

Differt a varietate anteriore cellulis magnis papillosis, lobulo elongatiore, vitta cum pluribus ordinibus ocellarum, perianthoque cum una ruda ventrali.

Description. — Plante petite, épiphyllé, appliquée au support, de la même taille que les autres taxons. Feuilles insérées sous un angle de 70-90° et distantes entre elles de 0,2 mm. Lobe ovale à réniforme, avec un sinus entre la carène et la marge inférieure du lobe, long de 0,4 mm. Lobule en sac, parfois réduit (Bao Lôc, 5.12.1959), allongé, long jusqu'au 1/3 du lobe. Carène arrondie, plus ou moins crénelée (pas de papilles sur la carène, Bao Lôc, 3.11.1961). Dent apicale nulle; papille hyaline piriforme au-dessus de la dent médiane, cette dernière à cellule terminale longue. Cellules apicales du lobe de la même taille et de la même forme que chez les variétés précédentes (7 µm de diamètre). Cellules basales un peu plus grandes. Vitta longue de 140 à 260 µm, assez indistincte, à plusieurs rangs de cellules en «escalier», certaines cellules de la vitta papilleuses. Nous n'avons pas observé de propagules sur ce taxon. Bractées périnthaires plus courtes que le périnthe. Périnthe en toupie avec une aile ventrale, à apex aplati et à bec peu visible. Épi mâle latéral, court, à deux étages de bractées fertiles.

Echantillons examinés. — CAMBODGE : Kampot, Mt Bokor, piste de Kamchay, 900 m, 29.3.1968, Tixier 3524 A.

JAPON : Riou Kiou, île Iriomoté, Mt Sonaidaké, 6.4.1934, Horikawa, HIRO 13433.

MALAISIE : Pulau Pinang, Penang Hill, 700 m, épiphyllé en bas fond à *Cyathia*, 13.4.1971, Tixier 5545, 5546, 5549, 5586 — Johore, Mt Ophir, 300 m, épiphyllé en forêt secondaire en bordure du lac, 20.4.1972, Tixier 6246.

VIETNAM : Lam Đông, Bao Lôc, 750 m, épiphyllé en forêt dense, 18.11.1959, Tixier s.n. — idem, 5.12.1959, Tixier s.n. — idem, forêt du pk 184, 700 m, 2.1.1960 (b), Tixier s.n. — idem, forêt derrière l'École d'Agriculture, 3.2.1960, Tixier s.n. — idem, 1.6.1961, Tixier s.n. — idem, 3.10.1961, Tixier s.n. (holotype, PC) — idem, Col des Bananiers, 120 m, épiphyllé en forêt dense, 3.3.1961, Tixier s.n.

3 — *COLOLEJEUNEA FLOCCOSA* (Lehm. et Lindenb.) Schiffn. var. *FLOCCOSA* (fig. 5 et 6) *Feddes Rep.* 124 : 21, 1953, pro parte.

C'est dans cette variété que se classe l'isotype de l'herbier de Genève, il faut donc lui réserver le nom de la variété typique.

Description. — Plante petite, épiphyllé, appliquée au support, de la même taille que les taxons précédents. Feuilles insérées sous un angle de 70-90° et distantes entre elles de 0,2 mm. Lobe de forme ovale, long de 0,5 mm, sans sinus entre la carène du lobule et la marge inférieure du lobe. Lobule en sac.

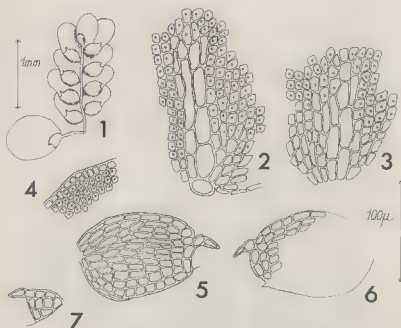


Fig. 5. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *floccosa* (Sorzogon). 1 : tige. 2-3 : vitta. 4 : apex du lobe. 5-6 : lobules. 7 : lobule réduit.

discoïde, parfois réduit (Kamchay, Maxwell's Hill), à carène arrondie, long de $1/3$ à $2/5$ du lobe. Dent apicale nulle. Papille hyaline piriforme, au-dessus de la dent médiane; dent médiane à cellule terminale courte. Cellules de l'apex du lobe isodiamétriques, de $7\mu\text{m}$ de diamètre; cellules basales de la même taille, mais un peu plus grandes sur l'échantillon malais. Vitta longue de 3-4 cellules, avec un rang d'ocelles et un rang de cellules compagnes allongées, plus étroites et vides. Parois de la vitta à trigones et épaississements intermédiaires. Propagules à 16 cellules. Plante monoïque. Inflorescence femelle à bractées périnthaires plus courtes que le périanthe. Périanthe cordiforme du fait du faible développement des oreillettes, plis ventraux peu marqués, bec court. Épi axial mâle à trois étages de bractées fertiles (Kamchay).

Échantillons examinés. - CAMBODGE : Kampot, Mt Bokor, Kamchay, 900 m, épiphyllé en forêt, 29.3.1968, Tixier 3424 idem, 1969, Tixier 4293, 4544.

FORMOSE : Prov. de Taihoku, Urai, 7.1928, Noguchi, HIRO 6203 - Botel Tobago, 17.2.1934, Fukuyama et Suzuki, HIRO 14498.

JAPON : Hondo, prov. d'Aki, île Miyajima, Mt Misen, 24.4.1931, Horikawa, HIRO 3378 - idem, 20.9.1931, Iwamasa, HIRO 5496 - idem, Iwamasa 1025, HIRO 5489.

MALAISIE : Pérak, Maxwell's Hill, 800 m, épiphyllé en forêt, 17.4.1972,

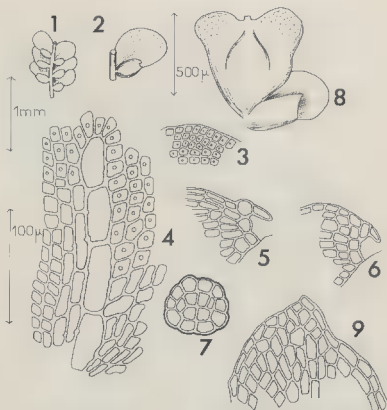


Fig. 6. — *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *floccosa* (Maxwell's Hill 6128). 1 : tige. 2 : feuille. 3 : apex du lobe. 4 : vitta. 5-6 : apex du lobule. 7 : propagule. 8 : périanthe. 9 : apex de bractée périanthaire.

Tixier 6128.

PHILIPPINES : Luçon, Sorzogon, ex hb Lindenberg 6180, ex hb Stephani 19121 (isotype).

4 - *COLOLEJEUNEA FLOCCOSA* (Lehm. et Lindenb.) Schiffn. var. *TRIVITATA* P. Tx. var. nov. (fig. 7 & 8).

Differt a C. floccosa vitta cum tribus ordinibus ocellorum.

Description. - Plante petite, épiphyllé, appliquée au support. Feuilles insérées sous un angle de 70-90° et distantes entre elles de 0,2 mm. Lobe petit pour le groupe, de 0,3 mm de longueur, de forme variée, ovale, avec ou sans sinus entre la carène et la marge inférieure de la feuille. Lobule en sac, généralement discoïde, à carène arrondie, rarement crénelée (Fraser's Hill), parfois réduit (Bao Lôc). Dent apicale nulle; papille hyaline piriforme, au-dessus de la dent médiane.

Dent médiane à cellule terminale courte et unique (sauf Ceylan 650, à deux cellules terminales). Cellules de l'apex du lobe isodiamétriques, de $7\text{ }\mu\text{m}$ de diamètre, sur plusieurs rangs sans papilles (Ceylan 650, Ceylan 681, Marojejy). Cellules basales papilleuses jusqu'à la naissance de la vitta dans la plupart des cas (sauf l'échantillon de Touho où les papilles ont déjà disparu dès le haut de la vitta). Vitta sigmoïde, atteignant $220\text{ }\mu\text{m}$, composée de 7 ocelles accompagnés d'un premier rang de cellules allongées et plus étroites, puis d'un rang de cellules plus courtes, de longueur variable. Propagules fréquents, à 16 cellules. Taxon rarement fructifié. Périanthe en toupie, à apex plat, situé au niveau des bractées périnthaires. Lobule de la bractée denticulé à l'apex. Périanthe haut de $0,4\text{ mm}$,

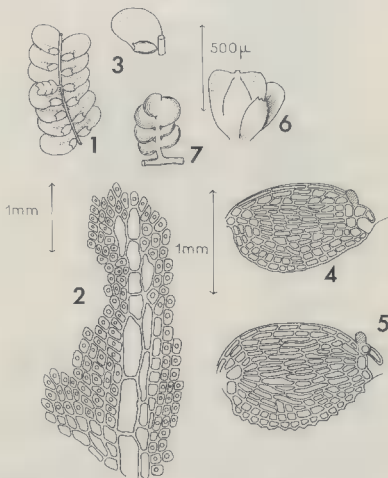


Fig. 7. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *trivittata* P. Tx. (Fraser's Hill 4634). 1 : tige. 2 : vitta. 3 : feuille. 4-5 : lobules. 6 : périante. 7 : épi mâle.

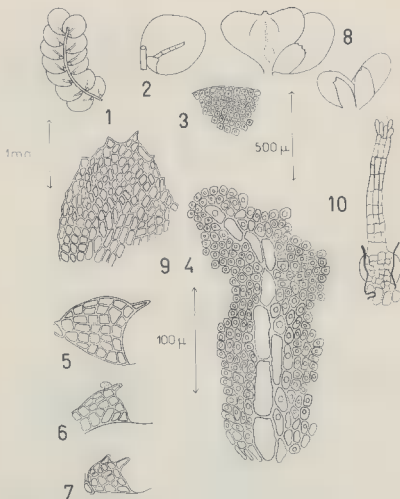


Fig. 8. — *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *trivittata* P. Tx. (Bao Lóc 2278). 1 : tige. 2 : feuille. 3 : apex du lobe. 4 : vitta. 5-7 : lobules réduits. 8 : périanthe et bractées périanthaires. 9 : apex du lobule de la bractée. 10 : archégone.

à apex plan et bec court. Épi mâle latéral, court, à 3 étages de bractées fertiles.

Echantillons examinés. — CEYLAN : Southern Province, Galle District, Hini-duma Kanda, épiphyllé sur *Litsea longifolia*, 400 m, 6.10.1974, Tirvengadam et Kostermans 630 (b), 650 — idem, Kennelyia Reserve Forest, clairière en basse région, 7.10.1974, Tirvengadam 681.

MADAGASCAR : Diégo-Suarez, massif du Marojejy, épiphyllé en forêt, 1000 m, 9.11.1958, Humbert & Saboureaux s.n. — Tananarive, Ambatoloana, 1100 m, 16.5.1976, Tixier 8347.

MALAISIE : Pérak, Maxwell's Hill, épiphyllé en forêt sous falaise, 1100 m, 18.4.1972, Tixier 6154, 6153, 6156 — Sélangor, Fraser's Hill, 1300 m, épiphyllé en forêt, 29.12.1969, Tixier 4634 (holotype, PC), 4688.

NOUVELLE-CALÉDONIE : Touho, Ponandou, 30 m, épiphyllé sur *Psychotria* en forêt galerie, 22. 3.1975, Mac Kee 29906 — idem, 23.3.1975, Mac Kee 29917 — Poindimi Povila, forêt humide sur schistes, épiphyllé sur *Freycinetia*, 26.9.1977, Mac Kee 33858 — Base du Col de Negacia, versant ouest de Camboui, 150, s.d., Veillon s.n. — Rivière Bleue, s.d., s.n. — Vallée de la Sunshine, 22.8.1951, Huerlimann 2748.

VIETNAM : Lam Dong, Bao Lóc, épiphyllé en forêt dense, 700 m, 5.12.1959, Tixier 2278 — Tuyên Duc, Dalat, Mt Lang Bian, 1900 m, 1959, Tixier s.n.

5 — COLOLEJEUNEA FLOCCOSA (Lehm. et Lindenb.) Schiffn. var. *PLICATA* P. Tx. var. nov. (fig. 9 & 10).

Differt ■ varietate typica anteriore periantho cum una ruda alata ventrali.

Description. — Plante petite, épiphyllé, appliquée au support. Feuilles insérées sous un angle de 70-90° et distantes entre elles de 0,2 mm. Lobe long de 0,3-0,4 mm, ovale, sans sinus entre la carène et la marge inférieure de la feuille. Lobule en sac, discoïde, à carène lisse ou crénelée (Kaptaï), parfois réduit (Kaptaï), atteignant le 1/3 de la longueur du lobe; dent apicale nulle, papille hyaline piriforme, au-dessus de la dent médiane. Dent médiane à cellule terminale longue. Cellules de l'apex du lobe de 7-10 µm de diamètre, les rangs marginaux sans papilles. Cellules basales plus grandes, papilleuses jusqu'au milieu de la feuille. Vitta droite, longue de 170-250 µm, à 4-8 cellules accompagnées de 1-2 rangs de cellules allongées plus étroites. Parois des ocelles à trigones et épaississements intermédiaires plus ou moins marqués. Propagules à 16 cellules. Plante monoïque. Périanthe en toupie, de 0,4-0,5 mm de haut, les plis ventraux formant une aile. Bractées périnthaires plus courtes que le périanthé; apex du lobule périnthaire généralement denticulé. Épi mâle latéral, à 2 étages de bractées fertiles.

Échantillons examinés. — BANGLADESH : Kaptaï, épiphyllé en forêt, 27.2.1965, Tixier 122.

CAMBODGE : Koh Kong, Kirirom, Phnom Prom, 700 m, épiphyllé en forêt, 18.4.1967, Tixier 2494.

JAVA : Tjibodas, 1400 m, épiphyllé en forêt, 15.4.1969, Tixier 4349 (holotype, PC).

Cette variété semble être celle qui se rapproche le plus de la variété *conivens* Ben. Bien que la diagnose n'en fasse pas état, le périanthé de cette variété est représenté, semble-t-il, avec une aile ventrale.

6. — COLOLEJEUNEA FLOCCOSA (Lehm. et Lindenb.) Schiffn. var. *ANGUSTIBRACTEATA* P. Tx. var. nov. (fig. 11 & 12).

Differt a varietate typica vitta longiore, dente apicali parva, lobuloque bractearum crenulato angustoque.

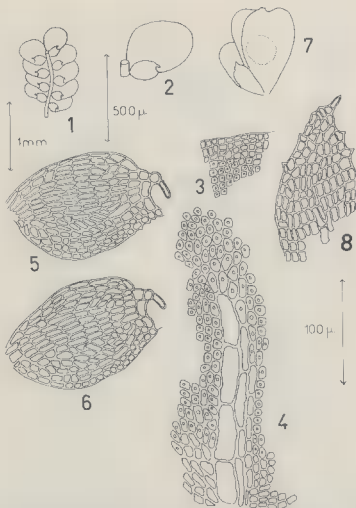


Fig. 9. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *plicata* P. Tx. (Tjibodas 4349). 1 : tige. 2 : feuille. 3 : apex du lobe. 4 : vitta. 5-6 : lobules. 7 : périanthe. 8 : apex de bractée périanthaire.

Description. — Plante petite, épiphyllé, appliquée au support. Feuilles insérées sous un angle de $70-90^\circ$ et distantes entre elles de 0,2 mm. Lobe ovale, sans sinus entre la marge inférieure du lobe et la carène du lobule, relativement grand, long de 0,5 mm. Lobule en sac, parfois réduit (Mt Maquiling), discoïde, à carène arrondie, atteignant du $1/3$ au $1/5$ de la longueur du lobe. Dent apicale nulle; papille hyaline au-dessus de la dent médiane; dent médiane à cellule terminale plus ou moins développée. Cellules de l'apex du lobe papilleuses, isodia-

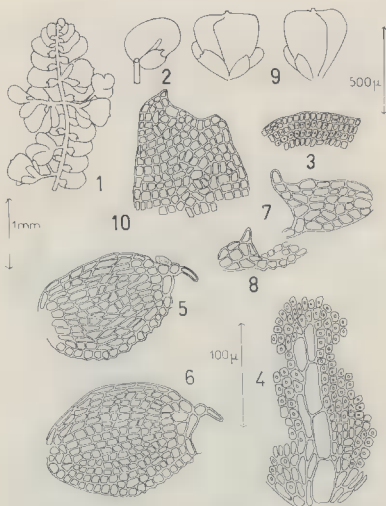


Fig. 10. -- *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *plicata* P. Tx. (Kaptal).
1 : tige. 2 : feuille. 3 : apex du lobe. 4 : vitta. 5-6 : lobules. 7-8 : lobules réduits. 9 :
périanthe. 10 : apex du lobule de bractée périnthaire.

métriques, de 7 μm , avec une tendance à différencier sur la marge des cellules rectangulaires allongées dont l'axe est dirigé dans le sens radial (comme chez *Cololejeunea peraffinis* Schiffn.). Cellules basales papilleuses jusqu'à la base de la vitta. Vitta sigmoïde, constituée de 7 cellules et longue jusqu'à 300-350 μm . Ocelles accompagnés par deux séries de cellules allongées et étroites. Parois des ocelles sans ornementation bien marquée. Propagules non observés. Plante parfois synoïque (Maxwell's Hill). Périanthe en forme de toupie, à apex aplati

et à bec peu marqué, haut de 0,4-0,5 mm. Bractées périnthaires atteignant plus ou moins la hauteur du périnthe. Lobule périnthe étroit et denticulé au sommet. Épi mâle latéral, à 2-3 étages de bractées fertiles.

Échantillons examinés. — MALAISIE : Pérak, Maxwell's Hill, 800 m, épiphyllé en forêt, 18.4.1972, Tixier 6136.

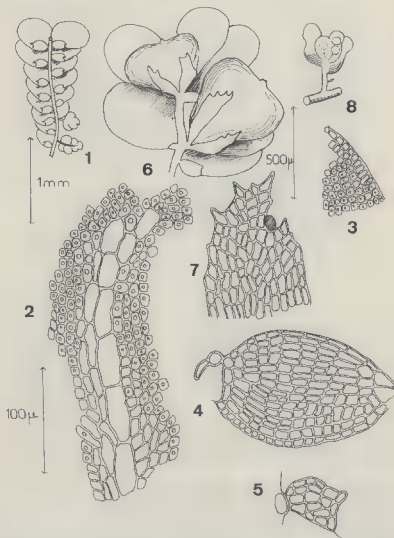


Fig. 11. *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *angustibracteata* P. Tx. (Mt Maquiling). 1 : tige. 2 : vitta. 3 : apex du lobe. 4 : lobule. 5 : lobule réduit. 6 : périnthe. 7 : apex du lobule de bractée périnthe. 8 : épi mâle.

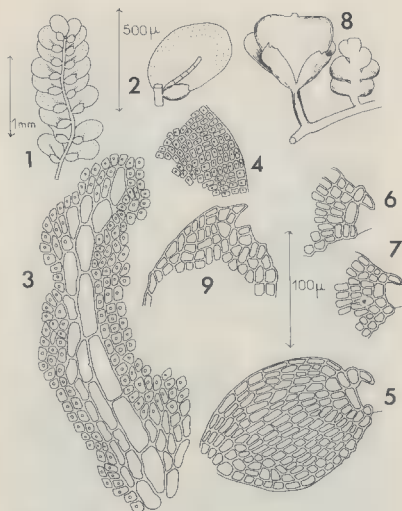


Fig. 12. — *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *angustibracteata* P. Tx. (Maxwell's Hill 6136). 1 : tige, 2 : feuille, 3 : vitta, 4 : apex du lobe, 5-7 : lobules, 8 : inflorescence synoïque.

PHILIPPINES : Luçon, Mt Maquiling, 1000 m, 10.7.1965, Tixier 1393 (holotype). Ce taxon semble le plus proche de celui représenté par BENEDIX comme étant *Cololejeunea floccosa* typique.

7 — *COLOLEJEUNEA FLOCCOSA* (Lehm. et Lindenb.) Schiffn. var. *OCELLATA* P. Tx. var. nov. (fig. 13 & 14).

Differt a specie typica, vitta longiore, ocellis perianthii.

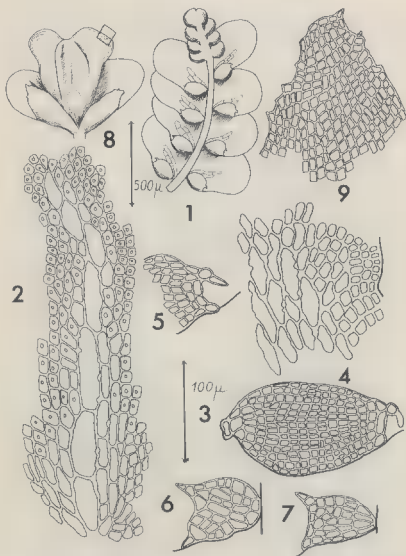


Fig. 13. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *ocellata* P. Tx. (Klong Riol). 1 : tige et épi mâle. 2 : vitta. 3 : lobule. 4 : vitta du périanthe. 5 : apex du lobule. 6-7 : lobules réduits. 8 : périanthe. 9 : apex du lobule périanthaire.

Description. — Plante petite, épiphyllé, appliquée au support. Feuilles insérées sous un angle de 70° et distantes entre elles de 0,2-0,3 mm. Lobe ovale, avec un léger sinus entre la marge inférieure du lobe et la carène, long de 0,45-0,5 mm. Lobule en sac, discoïde, à carène arrondie et lisse, parfois réduit, atteignant 1/3

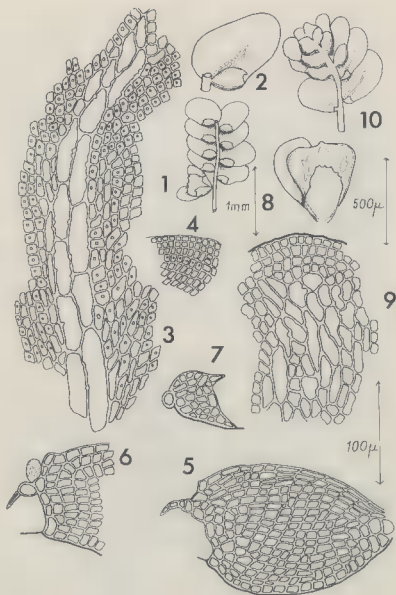


Fig. 14. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *ocellata* P. Tx. (Bao Lóc, 18.11.1959). 1 : tige. 2 : feuille. 3 : vitta. 4 : apex du lobe. 5-6 : lobules. 7 : lobules réduits. 8 : périanthe. 9 : vitta périanthaire. 10 : épi mâle.

à 2/5 de la longueur du lobe. Dent apicale visible, formant épaule; papille hyaline piriforme, au-dessus de la dent médiane. Dent médiane à cellule terminale longue, parfois dédoublée (Bao Lôc 18.11.1959). Cellules de l'apex du lobe isodiamétriques, de 7 μ m de diamètre, les papilles n'apparaissent qu'à la seconde ou à la troisième rangée de cellules. Cellules basales papilleuses jusqu'à la base de la vitta. Vitta grande, sigmoïde, longue de 300 à 370 μ m, à 7-8 grands ocelles accompagnés de deux séries de cellules longues et étroites. Trigones et épaississements intermédiaires marqués sur les parois des ocelles. Propagules à 16 cellules. Périanthé cordiforme, haut de 0,4-0,5 mm, à ailes peu marquées et plis ventraux formant aile, orné, dès la mi-hauteur, d'ocelles plus ou moins organisés en vitta. Bractées périanthaires à hauteur du périanthé; lobule des bractées large et denticulé au sommet. Épi mâle axial, à 3 étages de bractées fertiles.

Échantillons examinés. — CAMBODGE : Kampot, Mt Bokor, 900 m, piste forestière de Kamchay, 29.3.1968, Tixier 3524 B.

VIETNAM : Lam Đông, Bao Lôc, épiphyllé en forêt, 20.3.1958, Tixier s.n. idem, 18.11.1959, Tixier s.n. — idem, 11.1.1960, Tixier s.n. — idem, 19.1.1960, Tixier s.n. — idem, 21.1.1960, Tixier s.n. — idem, piste du Da Brinh, épiphyllé en forêt, 10.11.1960, Tixier s.n. — idem, piste de la Dalao, 900 m, 11.1.1960 et 21.2.1961, Tixier s.n. — idem, Santa Maria, forêt secondaire, 150 m, 17.1.1961, Tixier s.n. — idem, Klong Riôl, 600 m, 10.3.1961, Tixier s.n. (holotype, PC).

8 — *COLOLEJEUNEA FLOCCOSA* (Lehm. et Lindenb.) Schiffn. var. *AURICULATA* P. Tx. var. nov. (fig. 15).

Differt a varietate anteriore aliis perianthii, dente apicali minore, ocellis lobi paucioribus majoribusque.

Description. — Plante petite, épiphyllé, appliquée au support. Feuilles insérées sous un angle de 70° et distantes entre elles de 0,2 mm. Lobe ovale, sans sinus entre la carène du lobule et la marge inférieure du lobe, long de 0,4 mm. Lobule en sac, entier ou réduit, discoïde, à carène arrondie. Dent apicale non visible; papille hyaline piriforme; dent médiane à cellule terminale relativement courte. Cellules de l'apex du lobe isodiamétriques, de 7 μ m, à papilles seulement à partir du second rang de cellules. Cellules basales plus ou moins grandes selon l'échantillon et papilleuses jusqu'à la base de la vitta, au moins du côté de la marge supérieure du lobe. Vitta peu sigmoïde, longue de 270 à 300 μ m. Ocelles moins nombreux et plus grands que chez la variété précédente, accompagnés d'un seul rang de cellules allongées. L'ornement des parois des ocelles est nul. Propagules non observés. Périanthé à oreillettes marquées. Bec apparent et long. Ocelles en vitta à mi-hauteur du périanthé, lui-même haut de 0,5-0,6 mm. Bractées périanthaires à lobule peu denticulé au sommet. Épi mâle à trois étages de bractées fertiles.

Échantillon examiné. — NOUVELLE GUINÉE : Bismarck Gebirge, 18.10.1890, Lauterbach s.n. ex hb Steph. 19123 (holotype).

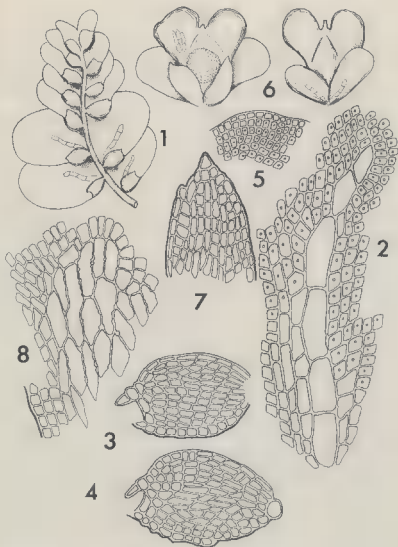


Fig. 15. - *Cololejeunea floccosa* (Lehm. et Lindenb.) Schiffn. var. *auriculata* P. Tx. (Nlle-Guinée). 1 : tige et épi mâle. 2 : vitta. 3-4 : lobules. 5 : apex du lobe. 6 : périanthe, face ventrale et dorsale. 7 : apex du lobule périanthaire. 8 : vitta périanthaire.

CONCLUSIONS

Ce travail est la somme d'une vingtaine d'années de récoltes et de réflexions. Quelques-unes de nos observations sont en contradiction avec celles de BENEDIX : nous n'avons pas pu voir le matériel étudié par cet auteur. Cependant, notre matériel a des origines plus variées et des aires de distribution plus vastes que celui de notre prédécesseur.

Nous n'insisterons pas ici sur la spéciation et la biogéographie dans le sous-genre *Taeniolejeunea* dont nous avons déjà donné une idée à propos de la section *Leonidentes*. Rappelons seulement les passages entre les différents taxons des sections *Floccosae*, *Falcatae* et *Globigeræ* de BENEDIX. Nous donnons (tab. 2) la répartition des différentes variétés au point de vue géographique, la variété dont l'aire est la plus étendue restant la var. *aurita*. Notons aussi que c'est dans les régions où nous avons le plus récolté que le matériel le plus abondant a été recueilli, c'est-à-dire au Vietnam. Étant affecté à l'École d'Agriculture de Bao Lôm, nous avons eu, durant plusieurs années, la forêt tropicale à notre porte.

Nous terminerons par deux remarques écologiques. Comme nous l'avons indiqué dans nos listes des mousses de Thaïlande (1971), il existe, sous les Tropiques en Asie du Sud-Est, trois zones climatiques : une zone équatoriale sans saison sèche, une zone tropicale à saison sèche chaude, une région tropicale à saison sèche fraîche. Dans la seconde de ces régions se rencontre la plus forte richesse spécifique chez les Cololejeunoidées. Cette région prend l'Asie du Sud-Est en écharpe, des Philippines à la Malaisie. La seconde remarque concerne l'influence de l'altitude. Dans la plupart des groupes de plantes épiphytes que nous avons étudiées au Vietnam, la richesse spécifique passait par un maximum dans l'étage de 500-1200 m. *C. floccosa* n'échappe pas à cette règle. La répartition des taxons suivant l'altitude (pour autant que nous connaissions celle-ci) montre que les diverses variétés ont un maximum de richesse spécifique entre 600 et 1200 m. Cependant, une certaine richesse en basse région est à noter. Les florules hépaticologiques épiphytes diminuent avec l'altitude, soit qu'elles disparaissent, soit qu'elles s'appauvrissent. Nous basons cette opinion sur nos récoltes au-dessus de 2000 m (2000 m au Mt Lang Bian au Vietnam, 1900 m au Mt Polis, à Luçon, 2100 m aux Palni Hills dans le Deccan, et enfin 2100 m dans l'Ankaratra, à Madagascar). Sur un point plus précis nous avons récolté 15 espèces de *Cololejeunea* au Mont Maquiling à Luçon, à 1000 m, et seulement 4 au Mont Polis.

Nous remercions bien vivement S. Hattori et H. Ando qui ont eu l'amabilité de nous prêter le précieux matériel du Japon. Notre reconnaissance va aussi à notre ami D.D. Tirvengadam qui nous a spécialement récolté du matériel épiphyte à Ceylan, ce qui nous a permis d'accroître sérieusement la connaissance des Lejeunéacées cinghalaises (TIXIER 1977). Nous ne pouvons pas oublier ici les contributions remarquables qu'ont constituées les récoltes néo-calédoniennes. Enfin, nous remercions P. Geissler, conservateur de l'herbier de Genève, qui nous a adressé le matériel de l'herbier Stephani.

ORIGINES	Variétés							
	AURITA	AMOEBOIDES	FLOCCOSA	TRIVITTATA	PPLICATA	ANGUSTIBRACTEATA	OCELLATA	AURICULATA
BANGLADESH					•			1
CAMBODGE	■		•		•			3
CEYLAN	■							2
JAPON	■			■				1
JAVA					•			1
LAOS	•							1
MADAGASCAR				•				1
MALAISIE			•	•		•		3
Nlle CALÉDONIE				■				1
Nlle GUINÉE								• 1
PHILIPPINES			■			■		■
THAÏLANDE	■							1
VIETNAM	•	•		•	•		•	• 6
	5	1	3	■	4	2	1	2

ALTITUDE	AURITA	AMOEBOIDES	FLOCCOSA	TRIVITTATA	PPLICATA	ANGUSTIBRACTEATA	OCELLATA	AURICULATA	
0-600 m	4			3	1			1	■
600-1200 m	2	1	2	3	2	2	1	1	16
> 1200 m				1	1				■

Tab. 2. - Répartition des taxons (géographie et altitude).

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CYTOLOGICAL OBSERVATIONS ON SOME WEST HIMALAYAN MOSSES. VI

S.S. KUMAR & S.K. VERMA

SUMMARY. — The meiotic chromosomes of 2 species each of *Mielichhoferia*, *Pohlia*, and *Anomobryum*, and of 5 species of *Brachymerium* are studied. Five of the investigated species, namely, *Mielichhoferia sasaokae* : $n = 11$, *Mielichhoferia* sp. : $n = 10$, *Brachymerium acuminatum* : $n = 10, 11$, *B. leptophyllum* : $n = 20$ and *B. sikkimense* : $n = 10$, are studied cytologically for the first time. Intraspecific polyploidy and aneuploidy is recorded in *Pohlia longicollis* ($n = 11, 20, 22, 22 + m$), *Brachymerium exile* ($n = 10, 11, 20$), and *B. nepalense* ($n = 22, 22 + m$). Heteromorphic bivalents are found in *Brachymerium acuminatum*, *B. exile*, *B. sikkimense*, *Anomobryum auratum* and *Anomobryum* sp. Triads are observed in *Brachymerium exile* and *B. sikkimense*.

The present note which deals with the cytological results in 11 species of 4 genera of the family Bryaceae is a continuation of our earlier communication (1980, in press) on the cytology of 11 species of *Bryum* from the Western Himalayas.

MATERIALS AND METHODS

The materials were collected from the Western Himalayas during the monsoon months (July 1975 to September 1977). The meiotic study was made by squashing the archesporial tissue in 2% acetocarmine. The slides were made permanent in Euparal. The vouchers are in the Herbarium of the Department of Botany, Panjab University, Chandigarh, India.

OBSERVATIONS AND RESULTS

Mielichhoferia sasaokae Broth. : $n = 11$ (Figs. 1-2) — This is the first cytological study of the genus. The investigated species (PU 3156), a new record for the Western Himalayas, was collected from Nainital (Kilbery forest, on wet shady rocks, 2300 m). The frequency of sporophyte formation was rather very low.

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Cryptog., Bryol. Lichénol., 1981, 2, 1 : 77-89.

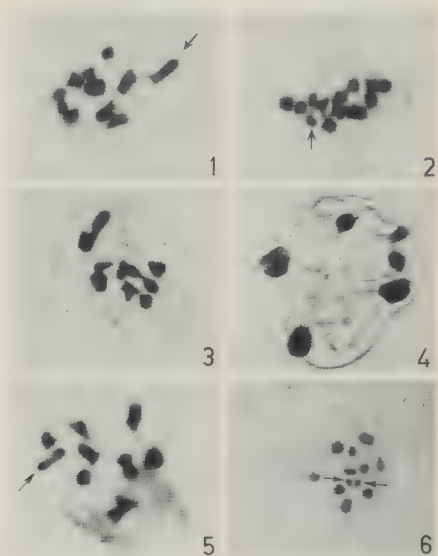
The reproduction appeared to be mainly through the perennation of old gametophores. The 11-chromosome complement included three relatively large bivalents, one of which was noticeably larger than the others (Figs. 1-2). In some sporocytes, a few laggards were observed at anaphase-I because of late disjunction in the first telophase nuclei. As judged from the morphology of the bivalents (Fig. 1), at least four chromosomes appear to be acrocentric.

Mielichhoferia sp. : $n = 10$ (Figs. 3-4) - This unnamed species (PU 3157), also gathered from Nainital (Kilbery forest, on rocks, 2300 m), showed abundant fruiting. The chromosome complement (Fig. 3) as in the previous species, showed three relatively large bivalents. In about 5% of the studied sporocytes, 1-2 laggards were observed at first and second telophases. In a few sporocytes abnormal meiotic behaviour, probably caused by the weak spindle, resulted in three apparently normal nuclei and three micronuclei (Fig. 4). It would be desirable to undertake chromosome sampling of several populations of this species to find out if the expected aneuploid numbers exist.

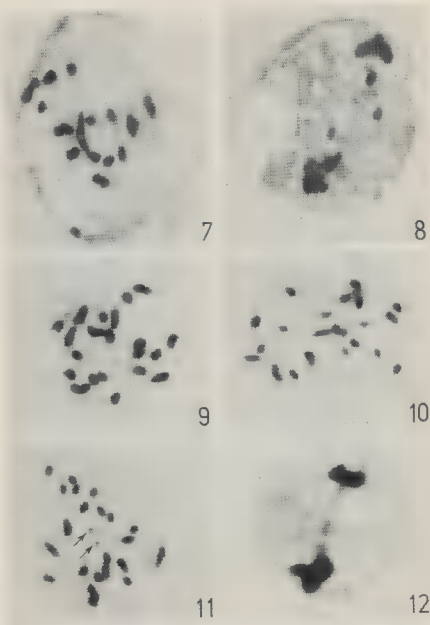
Poblia elongata Hedw. : $n = 11$ (Fig. 5) - The material studied (PU 3158) was collected from Nainital (Kilbery forest, on wet soil, 2300 m). One of the two large bivalents in the complement showed a tendency to disjoin precociously. As judged from the morphology of the bivalents, at least four chromosomes appear to be acrocentric. Earlier, the same chromosome number was reported for some other populations of this species (YANO 1957, PANDE & CHOPRA 1958, and SMITH & NEWTON 1967). In the European materials, however, SMITH & NEWTON (1967) observed irregular disjunction of the bivalents.

Poblia longicollis (Hedw.) Lindb. : $n = 11, 20, 22, 23 (22 + m)$ (Figs. 6-12) - Three collections of this nearly cosmopolitan species gave different chromosome counts. The material (PU 3159) gathered from Ranikhet (on soil, 1850 m), showed 11 bivalents at metaphase-I (Fig. 6). The smallest member of the set, recognizable as the h-bivalent, was lightly stained and anticipated disjunction of the set. Of the other two materials collected from Didihat (Ghurpatta, 1350 m), one (PU 3160, on soil) showed 20 bivalents (Fig. 7) which tended to lie in pairs, while in the other gathering (PU 3161, on dead logs of wood) 22 bivalents were counted at metaphase-I (Figs. 9-10). As judged from the morphology of the bivalents, four of the six large bivalents appeared to be metacentric. In few sporocytes from some of the capsules of this population, in addition to the normal 22 chromosomes, a faintly stained, dot-like, precociously disjoined m-bivalent was also observed (Fig. 11). This tiny chromosome appears to be floating in this population and is probably on its way to elimination. In 15-20% of the studied sporocytes from eudiploid and hypodiploid gatherings, 1-3 laggards were observed at anaphase-I (Fig. 8) and telophase-I. Sometimes an anaphase bridge was seen at the end of the first meiotic division in the eudiploid materials (Fig. 12).

KHANNA (1967) counted 11 bivalents in a population from Colorado and YANO (1957) reported $n = 22$ for the Japanese population of this species.



Pl. I. — 1-2 : *Mellichhoferia sasaokae* — $n = 11$. 1 : Metaphase-I; note the noticeably large bivalent. 2 : Metaphase-I; the arrow marked bivalent has disjoined. 3-4 : *Mellichhoferia* sp. — $n = 10$. 3 : Metaphase-I. 4 : Telophase-II, proceeding towards the constitution of 3 apparently normal and 3 micronuclei. 5 : *Pohlia elongata* — $n = 11$. Metaphase-I; note the precocious disjunction of one bivalent. 6 : *P. longicollis* — $n = 11$. Metaphase-I; note 2 half-bivalents (arrow marked) of the h-bivalent ($\times 2720$).



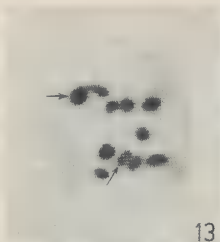
PL. II. - 7-8 : *Pohlia longicollis* - $n = 20$. 7 : Metaphase-I; note the tendency of a few bivalents to lie in pairs. 8 : Anaphase-I, showing laggards. 9-12 : *P. longicollis* - $n = 22, 23$ ($22 + m$). 9-10 : Metaphase-I. 11 : Metaphase-I; note two (arrow marked) half-bivalents of the m-bivalent. 12 : First anaphase bridge ($\times 2720$).

The quantitative differences in morphological characters (plant length, seta length and capsule size) between the haploid ($n = 11$, Fig. 32), diploid ($n = 22$, Fig. 33) and the hypodiploid ($n = 20$) materials appear to be environmentally controlled.

Of the reported chromosome numbers in 16 species of *Pohlia*, $n = 10, 11, 10 + 4 m, 20, 21, 22, 22 + m, 30, 44$ (FRITSCH 1972, DANYLKIV & VISOTSKAYA 1975, VISOTSKAYA 1975), $n = 11$ (or its multiple) is found in 13 taxa and may be regarded as the basic number for this genus. Further evolution and speciation in *Pohlia* seems to have been accomplished through polyploidy and aneuploidy.

Brachymenium acuminatum Hedw. : $n = 10, 11$ (Figs. 13-16) — Of the two gatherings of this so far cytologically uninvestigated species, the one (PU 3162) collected from Bhimtal (on soil, 1390 m) showed 10 bivalents with the largest, dimorphic, H-bivalent located at the periphery and anticipating disjunction of the set (Figs. 13-14). The smallest bivalent showed faint stainability and a tendency towards precocious disjunction (Fig. 14). The plants of the second collection (PU 3163) from Dharamsala (Tea Estate, 1500 m) showed 11 bivalents at first metaphase (Fig. 16). The largest member of the set, unlike that of the previous population, was not heteromorphic. As judged from the morphology of the bivalents, at least five chromosomes appear to be metacentric.

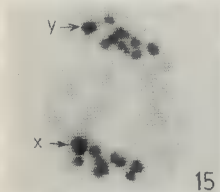
Brachymenium exile (Doz. & Molk.) Bosch. et Lac. : $n = 10, 11, 20$ (Figs. 17-24) — Of the six populations studied, three (PU 3164 - Almora, 1605 m; PU 3165 - Dharamsala, Tea Estate, 1500 m; PU 3166 - Narkanda, Hatoo Peak, 2700 m) showed $n = 10$. The complement included 3-4 large bivalents, of which the largest one anticipated disjunction of the set (Fig. 18). The resulting half-bivalents appeared slightly dissimilar. One large chromosome (arrow marked) appears to be involved in the organization of the nucleolus (Fig. 17). In two other populations (PU 3167 - Almora, 1605 m; PU 3168 - Didihat, 1450 m) 11 bivalents were counted at first metaphase (Figs. 19-20). In the Didihat population the largest bivalent was rod-shaped (Fig. 19) and, as in materials with $n = 10$, it disjoined precociously into two dissimilar half-bivalents. Occasionally the three smallest members of the set also anticipated disjunction. One or two chromosomes were observed as laggards at telophase-I (5-8% of the sporocytes) and telophase-II (12-15% of the sporocytes) in the Almora population. In the Didihat population, triads (Fig. 21) with one of the three nuclei (possibly of diploid constitution) of approximately double the size of the remaining two were observed in 5-8% of the studied sporocytes. The sixth population (PU 3169), gathered from Didihat and separated from plants (PU 3168) with $n = 11$ by a distance of nearly 200 m, proved diploid with $n = 20$. The bivalents could be grouped into 10 pairs with 3 pairs of relatively larger size (Figs. 22-23). Some of the bivalents tended to lie in pairs. Occasionally 2-3 bivalents failed to show normal orientation at the equatorial plate (Fig. 22). In about 37% of the sporocytes, 1-2 laggards were observed at telophase-II (Fig. 24), and in about 4% of the sporocytes triads were formed with one large (apparently diploid) and two small (apparently haploid) nuclei.



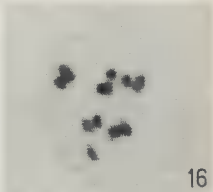
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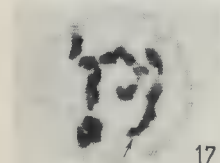
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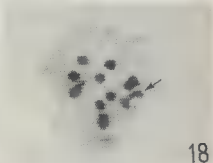
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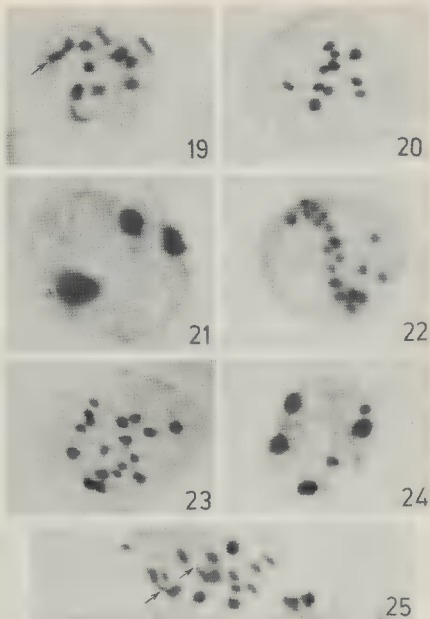


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Pl. III. - 13-15 : *Brachymenium acuminatum* - $n = 10$. 13 : Metaphase-I; note the large heteromorphic H-bivalent, and also the precocious disjunction of the small h-bivalent. 14 : Metaphase-I; note the large heteromorphic H-bivalent. 15 : Anaphase-I; note the difference in the size of X and Y components (arrow marked) of the heteromorphic bivalent. 16 : *B. acuminatum* - $n = 11$. Metaphase-I. 17-18 : *B. exile* - $n = 10$. 17 : Prometaphase; note the largest bivalent in association with the nucleolus. 18 : Metaphase-I; note the large, slightly heteromorphic H-bivalent (x 2720).



Pl. IV. -- 19-21 : *B. exile* - $n = 11$. 19-20 : Metaphase-I, note the heteromorphic bivalent in 19. 21 : A triad with one large (apparently diploid) and two small (apparently haploid) nuclei. 22-24 : *B. exile* - $n = 20$. 22-23 : Metaphase-I, showing 20 bivalents with 3 bivalents not oriented on the metaphase plate in 22. 24 : Telophase-II, showing laggards. 25 : *B. leptophyllum* - $n = 20$. Metaphase-I; note 2 h-bivalents (2720).

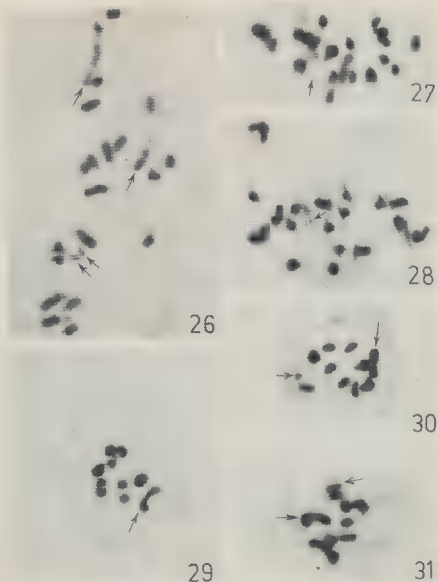
A morphological comparison of the haploid (PU 3164, PU 3165, PU 3166 : Fig. 34) and the diploid (PU 3169 : Fig. 35) populations of *B. exile* revealed that the diploid plants are taller (5.5-6.5 mm versus 1.7-2.0 mm) and possess larger basal areolations (34-51 x 17 μ m versus 17-36 x 10-17 μ m). Likewise plants of the Didihat population (PU 3168 : Fig. 36) with $n = 11$ are also taller (3.5-5.0 mm versus 1.7-2.0 mm) and have longer setae (1.6-2.5 cm versus 1.0-1.8 cm) than those of the plants (Fig. 34) with $n = 10$. However, plants of the Almora population (PU 3167 : Fig. 37) which also show $n = 11$ are not differentiable from plants (PU 3164, PU 3165, PU 3166) with $n = 10$. These quantitative differences in size in different populations seem to be linked with available humidity and shade conditions.

The close similarity between the plants of haploid and diploid constitution in essential morphological characteristics coupled with the cytological trait: (20 bivalents falling into 10 pairs, tendency of the bivalents to lie in pairs displayed by plants with $n = 20$ hints at the autopolyploid nature of the diploid materials. The formation of triads in the polyploid population is indicative of the receptivity of the genome to further polyploidy.

YANO (1957) counted 11 chromosomes in the somatic complement of the Japanese materials. GANGULEE & CHATTERJEE (1962) observed 11 bivalents in an East Himalayan population of this species.

Brachymenium leptophyllum (C. Muell.) Jaeg. : $n = 20$ (Fig. 25) - Unlike the preceding species of *Brachymenium*, which are either terrestrial or litho-phytes in our area, this species is corticolous growing on the trunks of broad leaved trees. The material studied (PU 3170) was collected from Bhimtal (1390 m) in a relatively open forest. This is the first cytological study of the species. The twenty bivalents observed at metaphase-I (Fig. 25) are grouped into ten pairs with three pairs of relatively large size. As judged from the morphology of the bivalents, one of the larger pairs appears to be acrocentric and another metacentric. Two members of the set, recognized as h-bivalents, showed faint stainability and displayed a tendency to anticipate disjunction. A careful survey of the area of colonisation of this seemingly autopolyploid taxon may result in the discovery of plants of haploid constitution.

Brachymenium nepalense Hook. : $n = 22, 23 (22 + m)$ (Figs. 26-28) - Of the three studied gatherings of this common epiphytic moss, two (PU 3171 - Dharamsala, Bhagsunath, 1900 m; PU 3172 - Dharamsala, on way to Triund, 1900 m) showed 22 bivalents which could be grouped into eleven pairs with one of the four large-sized pairs faintly stained and recognizable as the H-pair (Fig. 26). The smallest pair of the set, also faintly stained, corresponded to the h-bivalent. The duplicated genome is indicative of the autopolyploid nature of this species. As judged from the morphology of the bivalents, at least 6 chromosomes appear to be acrocentric. In the third population (PU 3173 - Bhimtal, 1390 m) a dot like, faintly stained m-bivalent showing precocious disjunction (Figs. 27-28) augmented the chromosome count. As judged from the morphology of the bivalents, at least 8 chromosomes (3 large and 5 small) appear to be metacentric (Fig. 28).



Pl. V. — 26 : *B. nepalense* — $n = 22$. Metaphase-I; note 2 large H-bivalents and 2 h-bivalents. 27-28 : *B. nepalense* — $n = 23$ ($22 + m$). Metaphase-I; note the precocious disjunction of the m-bivalent. 29 : *B. sikkimense* — $n = 10$. Metaphase-I; note the large heteromorphic bivalent. 30 : *Anomobryum auratum* — $n = 10 + acc.$ Metaphase-I; note the small dot-like peripherally located chromosome. Also note the precocious disjunction of the large heteromorphic bivalent (arrow marked). 31 : *Anomobryum* sp. — $n = 10$. Metaphase-I; note the large heteromorphic H-bivalent and one small h-bivalent ($\times 2720$).

GANGULEE & CHATTERJEE (1962) reported $n = 11, 12 (11 + m)$ in two East Himalayan populations of this species.

Brachymenium sikkimense Ren. & Card. : $n = 10$ (Fig. 29) – Cytological examination of two populations (PU 3174 - Ranikhet, on soil, 1850 m; PU 3175 - Hemkunt, on way from Gobind Ghat to Gobind Dham, on soil, 2850 m) of this previously uninvestigated species gave a consistent count of $n = 10$ (Fig. 29). One of the three relatively large bivalents of the complement was faintly stained and anticipated disjunction of the set. The resulting half-bivalents were dissimilar. In about 40% of the studied sporocytes, 1-2 laggards were observed at anaphase-I and telophase-II. Occasionally erratic meiotic behaviour resulted in the formation of triads.

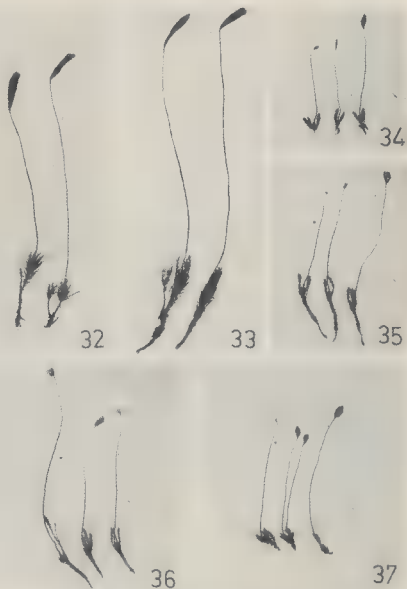
The chromosome numbers, $n = 10, 11, 12, 20, 22, 23, 30$ (FRITSCH 1972, RAMSAY 1977), known in 8 out of the 170 species included in *Brachymenium* suggest that polyploidy may be widely spread in this genus of largely tropical distribution. The basic number of the genus appears to be $x = 10$.

Anomobryum auratum (Mitt.) Jaeg. : $n = 10 + acc.$ (Fig. 30) – The material studied (PU 3176) was gathered from Didihat (Pam Tori, on soil, 1350 m). The largest bivalent of the set was slightly heteromorphic, faintly stained, and anticipated disjunction. A dot-like faintly stained accessory chromosome, in addition to the normal complement, was seen in the peripheral position in the sporocytes (Fig. 30). Occasionally 1-2 laggards were also observed at anaphase-I and anaphase-II. Earlier, GANGULEE & CHATTERJEE (1962) counted 10 bivalents in a Darjeeling population of this species. They, however, did not observe the distinctly large, heteromorphic bivalent in their materials. KUMAR (1973) reported a long chromosome in the somatic complement of a West Himalayan population which appears to correspond with the large bivalent seen in the presently examined material.

Anomobryum sp. : $n = 10$ (Fig. 31) – The investigated material (PU 3177) was collected from Nainital (Laria Kanta, on wet rocks, 2600 m). As in the previous species, the chromosome complement included a distinctly large, faintly stained, heteromorphic H-bivalent which disjoined precociously. One of the smaller bivalents, recognisable as the h-bivalent, was weakly stained at metaphase-I.

Three other investigated species of *Anomobryum* (*A. filiforme* var. *concinnum*, *A. gemmigerum*, *A. nitidum*) also show $n = 10$ (FRITSCH 1972) which may be regarded as the basic number for this genus.

The chromosome numbers reported for 90 species included in 11 genera of Bryaceae are : $n = 10, 11, 12, 14, 15, 20, 21, 22, 23, 24, 26, 27, 30, 33, 40$ and 50 (FRITSCH 1972, BRYAN 1973, DANYL'KIV & VISOTSKAYA 1975, INOUE 1976, KUMAR 1973, KUMAR & GARG 1974, KUMAR & VERMA 1980, NEWTON 1972, RAMSAY 1974, 1977, SNIDER 1970, TSUTSUMI et al. 1973, VISOTSKAYA 1972, 1975, WIGH 1972, WIGH & STRANDHEDE



PL. VI. — 32-33 : *Pohlia longicollis*. 32 : Plants with $n = 11$. 33 : Plants with $n = 22$.
 34-37 : *Brachymenium exile*. 34 : Plants with $n = 10$. 35 : Plants with $n = 20$. 36 :
 Plants with $n = 11$. 37 : Plants with $n = 11$ (x2).

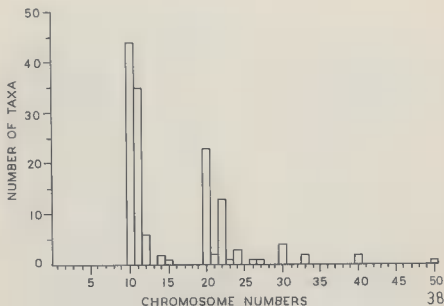


Fig. 38. — Histogram showing the distribution of chromosome numbers in Bryaceae.

1971). Of these numbers, $n = 10$ is found in 44 taxa and $n = 11$ in 35 taxa (Fig. 38). The original basic number of the family appears to be $n = 5$ which has either been lost or is still awaiting discovery. Thirty-seven species exist as euploids and 23 species are found as aneuploids. The only other family of acrocarpous mosses which shows a striking parallelism with Bryaceae in possessing the afore mentioned cytological traits is Pottiaceae (FRITSCH 1972, VERMA & KUMAR 1980). Incidentally the latter family also appears to be highly evolved in the haplolepidoid pool. The existing morphological plasticity obscuring generic, subgeneric and specific boundaries, coupled with cytological diversity, indicates that Bryaceae are in an active stage of evolution and speciation.

ACKNOWLEDGEMENT. — The authors are indebted to Prof. H. Ochi, Department of Botany, Tottori University, Japan, for his kind help in identifying the specimens.

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REPRODUCTIVE PHENOLOGY OF SOME TROPICAL AFRICAN MOSSES

E.A. ODU*

SUMMARY. - Four mosses, *Racomitrium africanum*, *Fissidens glauculus*, *Thuidium gratum* and *Stereophyllum* sp. were selected for field and laboratory studies on gametangia and sporophyte development over a period of 18-21 months in south-western Nigeria. Maturity indices of reproductive organs show that gametangia develop at the onset of the rainy season (March/April) while sporophytes develop later and mature towards and at the end of the same rainy season (October/November and December). Spores from the mature capsules of all species are dispersed during and after the dry season (November-April). The reproductive process from gametangia initiation to spore dispersal is completed in every 12-month cycle in both the perennial shoots of *Racomitrium*, *Thuidium* and *Stereophyllum* and annual shoots of *Fissidens*.

INTRODUCTION

Reproductive phenology for a given species of moss is the sequence of developmental stages from the start of gametangia production until the fall of dehiscent capsules. The ultimate goal of phenological studies is to explain factors which permit the development of a given stage in a species or in another taxon (FORMAN 1965). Thus formation of sex organs in bryophytes may be influenced by photoperiod (BENSON-EVANS 1961, 1964, ZEHR 1979) or temperature (BENSON-EVANS & HUGHES 1955, MONROE 1965, ANTHONY 1962) or even an interaction between climatic factors and endogenous rhythms in some species (NEWTON 1972, LONGTON 1979).

There is a great deal of information on patterns of gametangia and sporophyte development in temperate and polar bryophytes e.g. BENSON-EVANS and HUGHES (1955) on *Lunularia cruciata* (L.) Dum., GREENE (1960) on six British mosses, HUGHES (1962) on *Polytrichum aloides* Hedw. and *P. piliferum* Hedw., LONGTON and GREENE (1968) on *Pleurozium schreberi* (Brid.) Mitt., JOHNSEN (1969) on *Orthotrichum anomalum* Hedw. and HANCOCK and BRASSARD (1974) on *Buxbaumia aphylla* Hedw.

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There is little information available on the reproductive phenology of tropical African bryophytes. Equatorial Africa provide nearly non-seasonal conditions, Nigeria having only wet and dry seasons. Different parts of the country experience different durations of each season. In Western Nigeria vegetative growth of epiphyllous liverworts during the dry season was found to be much less than that in the wet (OLARINMOYE 1974) indicating the regulatory influence of moisture potential on growth. The present phenological study of selected mosses was undertaken to discern the timing of sexual developmental stages in relation to environmental factors in tropical African mosses.

MATERIALS AND METHODS

Moss shoots were sampled from natural populations of *Racomitrium africanum* Mitt., *Thuidium gratum* (P. Beauv.) Jaeg., *Fissidens glauculus* C. Müll. and *Stereophyllum* sp. at different locations in Ile-Ife (07°30'N, 04°40'E). Collections were made continuously at one month intervals for a period of 18-21 months (April 1978-December 1979) and the shoots examined fresh in the laboratory for gametangia and sporophyte development. Additional information was recorded for field collections of *R. africanum* and *T. gratum* between January and March 1979 at Ibadan (07°25'N, 03°53'E) and Owena (07°12'N, 05°E), *T. gratum* in February at Olokemeji (07°25'N, 03°32'E).

The reproductive stages recognized in the samples were those of GREENE (1960) slightly modified by LONGTON and GREENE (1969) and CLARKE and GREENE (1970). Index ratings were assigned to the developmental stages (Tab. 1).

Maturation stage	Maturity index
GAMETANGIA	
Juvenile (J)	1
Immature (I)	2
Mature (M)	3
Dehiscence (D)	4
SPOROPHYTE	
Swollen Venter (SV)	1
Calyptra in perichaetium, early (ECP)	2
Calyptra in perichaetium, late (LCP)	3
Calyptra intact, early (ECI)	4
Calyptra intact, late (LCI)	5
Operculum intact, early (EOI)	6
Operculum intact, late (LOI)	7
Operculum fallen (OF)	8
Empty and fresh (EF)	9

Tab. 1. Stages in maturation of gametangia and sporophytes in mosses (Source : CLARKE and GREENE 1970).

Gametangia and sporophyte stages for each species were scored monthly from 5 current cycle perichaetia/perigonia from each of 10 shoots and 50 sporophytes respectively. Mean index values or maturity indices (LONGTON and GREENE 1967) were then calculated from the formula :

$$\frac{\Sigma (\text{Index rating} \times \text{no. of gametangia/sporophytes})}{\text{Total no. of gametangia/sporophytes}}$$

Climatic data showing monthly total rainfall, number of rain days, relative humidity and temperature of the area around Ile-Ife during the period of study were obtained from the weather station of the Faculty of Agriculture, University of Ife.

RESULTS

Analysis of between 900 and 1050 perichaetia/perigonia in each of the species showed that there is a clearly defined seasonal cycle of gametangial development just as has been reported for several temperate mosses. Juvenile gametangia were usually first sited at the start of the rainy season between March/April and May of each year; majority of the gametangia dehisce in May (Fig. 2a) or June/July (Figs. 1a, 3a, 4a). It is apparent from Figs. 1a and 3a that antheridia develop earlier than archegonia in *Racopilum* and *Thuidium*. This phenomenon may also be possible in *Fissidens* and *Stereophyllum* where both sex organs were reported to develop in the same month (Figs. 2a and 4a) but was not detected probably due to the spacing (monthly) of field sampling. The differential development of male and female sex organs in these bryophytes may possibly be a device for preventing infraspecific self fertilization.

The time of fertilization is expected to be during the mature stage of the gametangia which is difficult to observe from field collections in large numbers. The low frequency of mature gametangia may be due to the short duration of the mature stage as has been suggested for some other mosses (GREENE 1960, LONGTON and GREENE 1969, ZEHR 1979). Thus the shortest period of fertilization occurs in May in *Fissidens* (Fig. 2a.). Fertilization occurs in May in *Racopilum* (Fig. 1a) but is earlier (March/April) in *Thuidium* and *Stereophyllum* (Figs. 3a and 4a). The apparently long duration between juvenile and dehiscent gametangia in *Thuidium* is probably due to its shaded, highly humid habitat (Fig. 6b). This may favour increased development of sex organs and fertilization.

Sporophytes in the swollen venter (SV) stage were first recorded for *Stereophyllum* immediately after fertilization in March-May 1979 (Fig. 4b). Development progresses rapidly in the same rainy season, the capsules maturing (LOI-OFF) towards the end of the rainy season in October (viz. Fig. 5).

After fertilization in April/May in *Fissidens* and *Thuidium*, sporophytes developed rapidly to ECI stage within the same month (Figs. 2b and 3b). However, sporophytes in all the mosses matured in October/November.

Spore dispersal (EF) occurred largely in *Fissidens*, *Thuidium* and *Stereophyllum* during the dry season, November-February/March (viz. Fig. 5). In *Raco-*

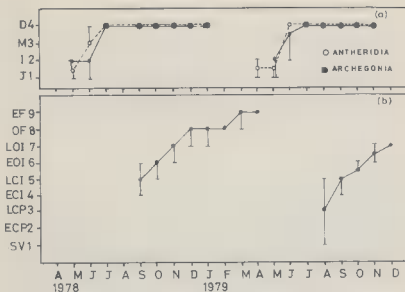


Fig. 1. — Maturity indices for *Racopilum africanum*; development of gametangia (above) and sporophyte (below). Vertical bars indicate the range of stages present.

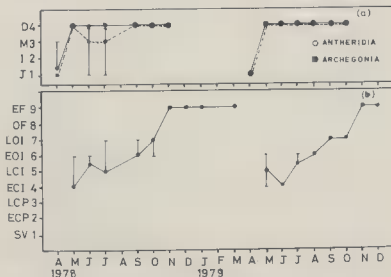


Fig. 2. — Maturity indices for *Fissidens glauculus*; development of gametangia (above) and sporophyte (below). Vertical bars indicate the range of stages present.

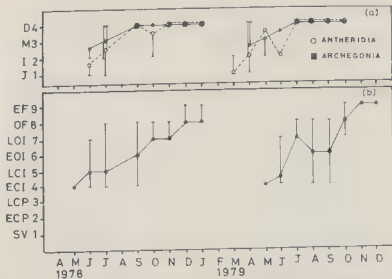


Fig. 3. - Maturity indices for *Thuidium gratum*; development of gametangia (above) and sporophyte (below). Vertical bars indicate the range of stages present.

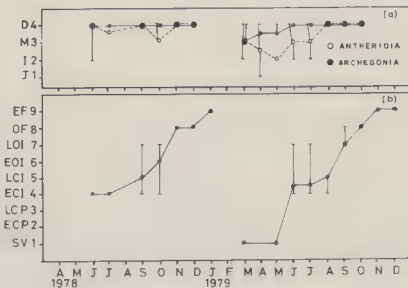


Fig. 4. - Maturity indices for *Stereophyllum* sp.; development of gametangia (above) and sporophyte (below). Vertical bars indicate the range of stages present.

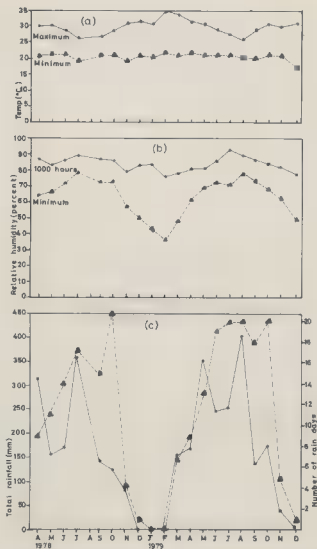


Fig. 5. — Climatic data recorded at Ile-Ife ($07^{\circ}30'N$, $04^{\circ}40'E$). (a) Maximum and minimum temperatures; (b) 1000 h and minimum relative humidity; (c) ■ total rainfall, ▲ no. of rain days.

pilum capsules matured fully between December and February with the spores being dispersed as from March.

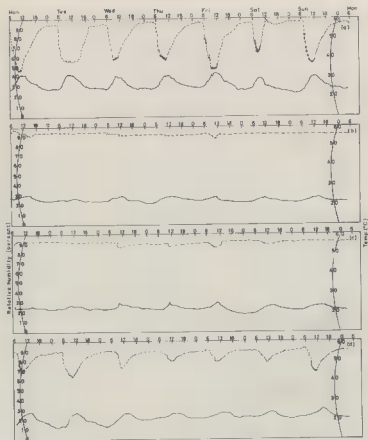


Fig. 6. — Microclimatic data recorded at ground level in one of the sampling sites at Ile-Ife in 1979. (a) 31 January-7 February (b) 18-25 June (c) 3-10 September (d) 17-23 December. Broken lines, relative humidity; continuous line, temperature.

DISCUSSION

The phenological data recorded for these selected mosses indicate that there seems to be clearly defined seasonal cycle of gametangia and sporophyte development in tropical African mosses. Similar patterns of cyclic behaviour have been reported for many temperate and polar bryophytes. In these latter bryophytes, however, cycles differ markedly between species (LONGTON 1979) and in the duration of sexual cycle. For instance while it takes 18 months for capsules of *Pylaisia polyantha* to mature (GREENE 1960) capsules of *Ptilium crista-castrensis* require over 3 years (Van der WIJK 1960 cited by LONGTON and GREENE 1969); spores from mature capsules of *Pleurozium schreberi* are

dispersed 15-20 months after gametangial initiation (LONGTON and GREENE 1969) but a similar cycle in the bipolar moss *Polytrichum alpestre* takes 24 months (LONGTON 1979). In the present studies the period between gametangial initiation and spore dispersal is a much shorter time, 7-10 months.

The regular alternate development of gametangia and sporophytes within a 12-month cycle in these mosses seems to be controlled mainly by climatic factors. This conclusion is based on this study and similar observations in several other mosses, both field and herbarium specimens, from a wide area of southern Nigeria over an 11-year period, 1968-1979; the observations show a consistent occurrence of mature sporophytes only in shoots collected between October/November and February. In the area of study, gametangia development, fertilization and sporophyte development occur only during the extended cool and wet months (March-October) of the biseasonal annual cycle (Fig. 5).

It is difficult to ascertain the role of photoperiod in the induction of sexual organs without laboratory or field experimental data. The area covered in the field study experiences equinoxes in March and September, slightly long days during May-July and slightly shorter days in December-February. Indications ■ that gametangial development during April-May is probably partially controlled by the slightly long days but this needs to be verified experimentally. Additional stimulus for gametophore production could also be provided by the diurnal fluctuations in temperature (Figs. 5a and 6a-b) as has been suggested for male *Mnium undulatum* (NEWTON 1972).

Sporophytes of all the species that matured at the end of the rainy season disperse their spores during and at the end of the dry season. The intervening dry period is necessary for shedding of the opercula (JOHNSON 1969), effective maturation and dispersal of the spores ready for germination at the onset of the next rainy season. This is of survival value for *Fissidens glauculus*, an annual that has been suggested to become established in the field only by spore germination (ODU 1979).

The salient point emerging from this study indicates that in a 12-month cycle, maturity of sex organs, fertilization and sporophyte development are all coordinated to take place during the rainy season while capsule dehiscence and spore dispersal occur in the dry season. Gametangia and sporophyte development take approximately 1-4 and 6-8 months respectively with no resting phase of any kind.

An endogenous rhythm in coordination with the season seems to influence the reproductive process in *Racomitrium* where capsules matured during the dry season (December-February) even though fertilization occurred early in the rainy season (May/June). Further studies are therefore necessary on the reproductive phenology *vis-à-vis* shoot growth of mosses and the tropical climatic factors.

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SPORE ORNAMENTATION IN LEIOMELA

(Musci : Bartramiaceae)

D. GRIFFIN, III *

SUMMARY. — The spores of 4 species of *Leiomela* were examined by light microscopy, and 1 species, *L. bartramioides*, was examined also by scanning electron microscopy. All 4 species produce spores with a reticulate pattern of surface ornamentation. This type of ornamentation has not been reported previously in the Bartramiaceae.

INTRODUCTION

The utility of spore ornamentation in moss systematics differs from one taxonomic group to another (for general review see CLARKE 1979), and for many families and genera it is not yet possible to state what that utility might be. In *Encalypta* (JARAI-KOMLODI and ORBAN 1975, VITT and HAMILTON 1974), *Bruchia* (McCLYMONT 1955) and some other genera there appear to be significant differences in spore ornamentation at the species or species complex level. On the other hand, SAITO and HIROHAMA (1974) discovered that in several genera of Pottiaceae the patterns of spore ornamentation do not always correlate with taxonomic concepts. They argued that on the basis of similarities in spore ornamentation the genera *Astomum* and *Hymenostomum* could not be maintained apart from *Weissia*. In the Bartramiaceae it is known that several major discontinuities in spore ornamentation occur (BOROS and JARAI-KOMLODI 1975, ERDTMAN 1965, MATTERI 1968, 1973, MIYOSHI 1973, HIROHAMA 1977), especially at the generic level; however, many gaps remain in our knowledge of spore morphology in this family. Relatively little is known of spore morphology in *Leiomela*, for instance, and with this in mind the present study was undertaken.

METHODS AND MATERIALS

Spores of the following 4 species were used in this investigation : *Leiomela africana* Thér. et Nav., *L. aristifolia* (Jaeg.) Wijk et Marg., *L. bartramioides* (Hook.) Par. and *L. javanica* (Ren. et Card.) Broth.

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Specimens examined. — *L. africana*, TANZANIA, Ukaguru Mts N of Kilosa town, on *Cyathea* stems, T. Pócs, B.F. Harris and Mrs. Mwansabe 6592/K, 25 May 1972. *L. aristifolia*, ECUADOR, summit of Pichincha, in rock crevices, Jameson s.n., Sept. 1847 (type). *L. bartramioides*, VENEZUELA, Mucuy above the town of Tabay, on trunk of tree fern, Griffin, López F. and L. Ruiz-Terán 1838, 7 Aug. 1972. *L. javanica*, JAVA, am Gedeh bei Kandang-Badak an Baumrinde, Fleischer 17286, 18 Juli 1898.

Light microscopy. — Spores from mature capsules were heated gently in water and then mounted on glass slides in Hoyer's solution. Ten spores of each species were measured and the measurements averaged. A few spores of each species were heated and measured in water mounts to check on possible size changes in water versus Hoyer's-mounted material. No perceptible changes were observed, and the Hoyer's-mounted spores were used for measuring and for photomicrography.

Scanning electron microscopy. — Spores of *L. bartramioides* were studied by SEM. Spores for this study were mounted dry on squares of 2-sided adhesive tape affixed to aluminium stubs. The spores were gold coated using an Eiko sputter-coater and later examined at 20 KV with a Hitachi S 450 scanning electron microscope.

RESULTS

Spores of the 4 species of *Leiomela* examined in this study were of similar shape and surface ornamentation but differed somewhat in size. The mature spores are subspherical to spherical, apolar, with little or no discernable difference in surface ornamentation between distal and proximal faces. The averaged sizes are as follows (length/width — 10 spores measured for each species): *L. africana*, $31\ \mu \times 29\ \mu$; *L. aristifolia*, $31\ \mu \times 30\ \mu$; *L. bartramioides*, $34\ \mu \times 32\ \mu$; *L. javanica*, $38\ \mu \times 36\ \mu$.

The basic type of ornamentation is found in all 4 species examined (Figs. I, II and III). The sculpturing is a reticulum with the muri showing perfect or imperfect fusions. The lacunae are short-oblong to rectangular and vary from $0.5\ \mu$ to $4\ \mu$ in long dimension.

DISCUSSION

Because of the small sample size no significance is attributed to the differences in spore sizes among the 4 species. The reticulate ornamentation is of interest in that this type has not been reported previously for the Bartramiaceae. Several other genera (e.g., *Bartramia*, *Conostomum*, *Breutelia* and *Plagiopus*) show some form of verrucate ornamentation while in *Philonotis* a number of types are known, including baculate, clavate and pilulate.

Leiomela is a small and morphologically somewhat isolated genus of the Bartramiaceae. It is now seen to have an unusual, if not unique, type of spore

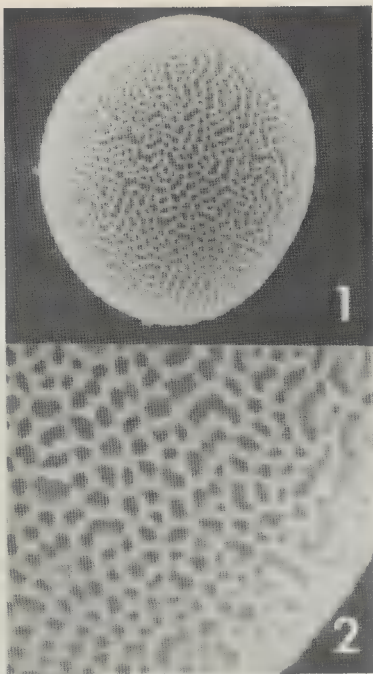


Fig. 1. - Spores of *Leiomela bartramioides* (Hook.) Par., Venezuela, Griffin et al., 7.VIII. 1972. - 1 : Whole spore, $\times 2450$. 2 : Detail of surface ornamentation, $\times 5000$.

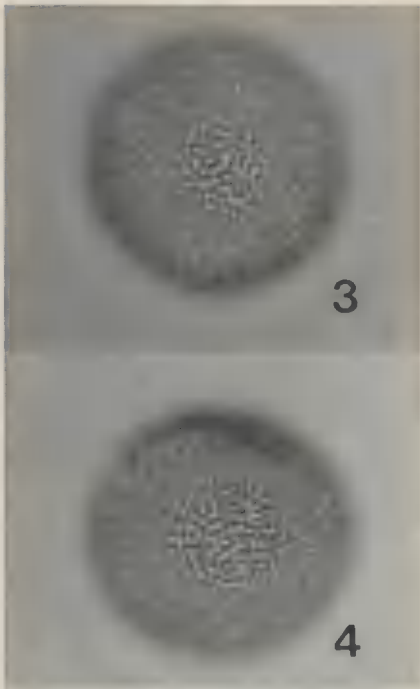


Fig. 11. Spores of *Leiomela*. — 3 : *L. africana* Thér. et Nav., Tanzania, Pócs et al., 25.V. 1972, x 2000. 4 : *L. aristifolia* (Jaeg.) Wijk et Marg., Ecuador, Jameson, 1847, x 2000.

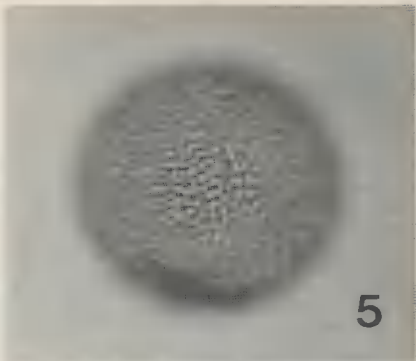


Fig. III. - Spores of *Leiomela*. - 5 : *L. bartramioides* (Hook.) Par., Venezuela, Griffin et al., 7.VIII.1972, x 2000. 6 : *L. javanica* (Ren. et Card.) Broth., Fleischer, 1898, x 2000.

ornamentation. This supports the generic concept for *Leiomela*; however, it remains to be seen (GRIFFIN 1980) whether the patterns of spore ornamentation can be used to help refine and improve the concepts on which the other genera of the family are based.

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Grolle) et sect. *Metaclasmatocolea* (*C. navistipula* et la var. *parceramosa* Engel); subgen. *Squamicalyx* subgen. nov. (esp. type : *C. notophylla* (Hook. f. et Tayl.) Grolle; + *C. verrucosa* Engel); subgen. *Plicaticalyx* subgen. nov. (esp. type : *C. cucullistipula* (Steph.) Grolle). Noter les nouv. synonymes. Index.

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21 taxons sont reconnus, clé.

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Les parois externes des cellules de la cavité haustoriale développent des labyrinthes typiques des cellules de transfert; ceci est très apparent dans les cellules épidermiques du pied du sporophyte. Description de 3 stades. Relation avec les changements dans les possibilités de translocation gamétophyte-sporophyte.

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FELLE H. and BENTRUP F.W. — Hexose transport and membrane depolarization in *Riccia fluitans*. *Planta* 1980, 147, 5 : 471-476, 1 tabl., 9 fig. (Abt. Biophys. Pfl., Inst. Biol. I der Univ., D-7400 Tübingen).

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VANDEKERKHOVE O. — Stabile Wachstumsanomalien bei *Riccia fluitans* nach längerer Einwirkung von Phenylborsäure auf die Vegetationspunkte. *Naturwissenschaften* 1980, 67, 2 : 96-97, 1 fig. (Inst. Allg. Bot., Univ., D-6500 Mainz).

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Loc. en Tchécoslovaquie, bibliogr. : 125 - *Marsupella sprucei* (Limpr.) Bern. - 128 - *M. brevissima* (Dum.) Grolle - 141 - *Gymnomitrium coralloides* Nees - 143 - *G. obtusum* (Lindb.) Pears. - 241 - *Porella cordaeana* (Hüb.) Moore.

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- HIRANO H. and SUZUKI T. — *Lejeunea magohuki* Mizut. occurs in Shizuoka-ken, Central Japan. *Proc. Bryol. Soc. Japan* 1978, 2, 5 : 68, en japonais.
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20 hépatiques et 78 mousses rencontrées au cours de l'excursion.
- KIGUCHI H. — *Fissidens* in Agano district, Saitama Prefecture, Central Japan. *Proc. Bryol. Soc. Japan* 1978, 2, 5 : 62-64, en japonais (11 esp.).
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- KITAGAWA N. — *Lunularia cruciata* and *Monoselenium tenerum* in Nara City. *Proc. Bryol. Soc. Japan* 1978, 2, 5 : 69, en japonais.
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- LECOINTE A. — *Southbya nigrella* (De Not.) Spruce, *Cephaloxiella baumgartneri* Schiffn. et *Tortella inflexa* (Bruch) Broth., bryophytes nouvelles pour la Basse-Normandie, aux Carrières d'Orival, près de Creully (Calvados). *Bull. Soc. Linn. Normandie* 1979, 107 : 47-60, 5 cartes (Lab. Phytogéogr., UER Sci. Terre et Aménagement. Région., Univ. Caen, F-14302 Caen Cedex).
Biotopes et groupements bryologiques de cette localité menacée de destruc-

tion. 28% des esp. appartiennent au cortège méditerranéen s. l. 3 esp. sont nouv. pour la Basse-Normandie.

LECOINTE A. — Intérêts phytogéographiques de la bryoflore normande : 1 - Les cortèges cosmopolite et méditerranéen s. l. *Bull. Soc. Linn. Normandie* 1979, 107 : 61-70, 1 carte (Idem).

A l'aide de l'étude des cortèges cosmopolite et méditerranéen s. l. (respectivement 10 et 22% de l'ensemble), l'A. précise certaines de ses conceptions personnelles sur la définition et la désignation des aires biogéographiques pour les bryophytes.

LEE T.D. and LA ROY G.H. — Bryophyte and understory vascular plant beta diversity in relation to moisture and elevation gradients. *Vegetatio* 1979, 40, 1 : 29-38, 2 fig., 3 tabl. (Dept. Bot., Univ. Alberta, Edmonton, Alberta T6G 2E9, Canada).

La diversité beta (changement dans la composition en esp. selon un gradient d'habitat) des bryophytes et des plantes vasculaires est semblable pour l'humidité dans les 3 zones de végétation étudiées. Elle est plus importante chez les plantes vasculaires selon le gradient de l'élévation dans les 4 régimes d'humidité. Les bryophytes apparaissent plus tolérants aux facteurs liés à l'altitude, incluant la température.

NAKAMURA T., SUGITA H. and INOUE H. — Flora and ecology of Bryophytes in the National Park for Nature Study. *Misc. Rep. Natl. Park Nat. Stud.* 1979, 9 : 61-73, 9 fig., 2 tabl. (Lab. Forest Bot., Fac. Agricult., Univ. Tokyo).

Liste des 52 esp. récoltées. Écologie des bryophytes terricoles et épiphytes. Évolution de la bryoflore depuis 1954.

PECIAR V. — Studia bryofloristica Slovaciae XI. *Acta Fac. Rerum Nat. Univ. Comenianae, Bot.* 1979, 27 : 151-161 (Lehrst. Syst. Bot. Naturwiss. Fak. Komensky Univ., 80100 Bratislava, Tchécoslovaquie).

Liste des esp. d'hépatiques et de mousses avec loc.

PROVOST M. et LECOINTE A. — Compte-rendu de l'excursion botanique faite par la société linnaéenne de Normandie en forêt de Grimboisq (Calvados) le 11 juin 1978. *Bull. Soc. Linn. Normandie* 1979, 107 : 83-90 (Lab. Phytogéogr., UER Sci. Terre et Aménagement. Région., Univ. Caen, F-14032 Caen Cedex).

Stations visitées avec esp. rencontrées (phanérogames, bryophytes, lichens).

REYES D.M. — Nuevos reportes para la flora hepaticologica de America latina, I. *Acta Bot. Acad. Sci. Hung.* 1979, 25 (2-3) : 359-360 (Inst. Bot., Acad. Sci. Cuba, La Havane, Cuba).

Liste de 26 esp. avec loc. en Amérique latine. 11 sont nouv. pour la région de la Gran Piedra, Cuba. *Aphanolejeunea ephemeroides* Schust., *Colura greig-*

smithii Jovet-Ast, *C. tenuicornis* (Evans) Steph., *Drepanolejeunea lichenicola* (Spr.) Steph., *Prionolejeunea helleri* Evans et *Radula pallens* (Sw.) Dum. sont nouv. pour Cuba.

SHIMOSE S. — *Cololejeunea aoshimensis* (Horik.) Mizut. found in Takashima Island, Shimane Prefecture, Japan. *Proc. Bryol. Soc. Japan* 1978, 2, 5 : 61-62, 9 fig., en japonais.

SZMAJDA P. — Bryoflora Gor Stolorowych i jej charakterystyka Geobotaniczna. *Prace Komis. Biol.* 1979, 52 : 1-80, 14 fig., 4 tabl. (Dept. Geobot., Adam Mickiewicz Univ., 61-713 Poznan, Pologne).

Bryoflore des Monts Stolorowe et ses caractéristiques géobotaniques. Descr. de la région (géol., climat, végétation). Liste systématique de 272 esp., 20 sous-esp. et 9 fo. de mousses et sphaignes avec loc. Distrib. verticale. Analyse floristique.

WALTHER J.M.N. — Groupements muscinaux dans les Vosges moyennes. *Bull. Soc. Hist. Nat. Colmar* 1975-1977 (1979), 56 : 91-102, 2 fig., 2 phot., 15 tabl. (Inst. Bot., Lab. Écol. Végét., Univ. Louis Pasteur, F-67000 Strasbourg).

152 relevés sur 3 types de substrat permettent de définir 9 groupements saxicoles, 3 épixyles et saprologinicoles, 3 sur rochers et troncs d'arbres, 2 épi-phytes corticoles. Structure et dynamique de ces groupements.

YAMADA K. and LAI M.J. — Five *Bazzania* species new to Taiwan. *Misc. Bryol. Lichenol.* 1979, 8, 5 : 87 (Ujiyamada High School, Uruguchi, Ise-shi, Mie-ken, Japan).

B. conophylla (Sde Lac.) Schiffn., *B. imbricata* (Mitt.) Hatt., *B. ovistipula* (Steph.) Abeyw., *B. shikkimensis* (Steph.) Herz., et *B. vittata* (Gott.) Trev. nouv. pour Taïwan.

POLLUTION

FERGUSON P. and LEE J.A. — Some effects of Bisulphite and Sulphate on the Growth of *Sphagnum* species in the Field. *Environm. Pollut. Ser. A* 1980, 21, 1 : 59-71, 7 tabl., 3 fig. (Dept. Bot., Univ. Manchester, M 139 PL Great Britain).

Effet principal : réduction de croissance.

ROBERTS B.A., THOMPSON L.K. and SIDHU S.S. — Terrestrial bryophytes as indicators of fluoride emission from a phosphorus plant, Long Harbour, Newfoundland, Canada. *Canad. J. Bot.* 1979, 57, 15 : 1583-1590, 5 fig., 2 tabl. (Newfoundland Forest Res. Centre, Canad. For. Serv., P. O. Box 6028, Pleasantville, St John's Newfld., Canada A1C 5X8).

L'étude porte principalement sur *Polytrichum commune*. Observation d'une

chlorose bénigne des phyllides allant jusqu'au brunissement à 95%. Concentration des fluorures dans les différents tissus; comparaison avec celle des fluorures dans les aiguilles du sapin baumier, des fluorures présents dans l'humus et dans l'air. Les Bryophytes apparaissent comme bons indicateurs de pollution.

STEFAN M.B. and RUDOLPH E.D. — Terrestrial Bryophytes as Indicators of Air Quality in Southeastern Ohio and Adjacent West Virginia. *Ohio J. Sci.* 1979, 79, 5 : 204-212, 4 fig., 3 tabl. (Dept. Bot., Ohio State Univ., Columbus, Ohio 43210 U.S.A.).

Cartographie utilisant *Dicranum scoparium*, *Leucobryum albidum* et *Polytrichum ohioense* comme indicateurs de pollution par SO_2 et chrome.

VARIA

DÖBBELER P. — Untersuchungen an moosparasitischen Pezizales aus der Verwandtschaft von *Octospora*. *Nova Hedwigia* 1979 (1980), 31, 4 : 817-864, 12 fig. (Inst. Syst. Bot., Menzingerstr. 67, D-8000 München 19).

Octospora et les genres alliés parasitent les rhizoïdes entraînant la formation d'innovations et quelquefois les cauloïdes et les feuilles. Révision systématique du genre *Octospora*. Noter que les Humariaceae, apparemment pyrénocarpes, parasites des hépatiques feuillées, font partie de *Octosporella* gen. nov. (d'où les comb. nov. : *O. hemicrypta*, *O. jungermanniarum*, *O. perforata*, *O. suboperculata*) et non du genre *Pseudonectria*. Relations parasite-plante hôte. Bryophilie.

ISOVIITA P. — S.O. Lindberg's bryological reports in Finnish newspapers. Critically annotated facsimile collection. *Helsingin yliopiston kasvimuseon monisteita* (Pamphlet Bot. Mus., Univ. Helsinki) 1980. 8 : 1-88 (Bot. Mus., Univ. Helsinki, SF-00170 Helsinki 17).

Les minutes des réunions de la «Societas pro Fauna et Flora Fennica» ont paru en suédois dans les journaux : *Helsingfors Dagblad*, *Morgonbladet* et *Finland*; elles comportent la publication de nombreux nouv. noms de plantes. S.O. Lindberg y a publié valablement autour de 90 nouv. noms ou nouv. combinaisons. L'A. nous propose, en facsimilé, les notes bryologiques (1865-1887) de Lindberg qui ont paru dans ces quotidiens, avec une liste des nouveautés nomenclaturales. Aucune altération dans la nomenclature établie n'est proposée, sauf pour *Gymnomitrium obtusum* Lindb., qu'il faut citer (Lindb.) Pears.; discussion de cert. autres status. Cet important document est accompagné de notes historiques, et met en valeur l'importance des journaux non-scientifiques dans la nomenclature, mais aucune proposition formelle n'est présentée pour modifier les règles actuelles. Le travail de recherche reste à faire pour d'autres auteurs en d'autres régions.

LECOINTE A. — A propos de la cartographie en réseau : deux exemples, remar-

ques et appel. *Bull. Soc. Linn. Normandie* 1979, 107 : 46 (Lab. Phytogéogr. UER Sci. Terre et Aménagement. Régional, Univ. Caen, F-14032 Caen Cedex).

SEAWARD M.R.D. — Two letters of bryological interest from Richard Spruce to David Moore. *Naturalist* (N. England) 1980, 105 : 29-33.

D. Moore (1807-1879), était superintendant puis conservateur du National Bot. Garden., Glasnevin, Dublin.

SYNNOTT D.M. — A catalogue of collectors in the bryophyte herbarium, National Botanic Garden, Glasnevin (DBN). *Glasra* 1980, 4 : 17-30 (Natl. Bot. Gard., Glasnevin, Dublin 9, Ireland).

BIBLIOGRAPHIE LICHÉNOLOGIQUE

D. LAMY

SYSTÉMATIQUE, NOMENCLATURE

CRESPO A. y SANCHO L.G. — Umbilicariaceae (Lichenes) de la Sierra de Guadarrama (España). *Anales Inst. Bot. Cavanilles* 1978 (1980), 35 : 79-101, 5 fig., 2 tabl. (Dept. Bot., Fac. Farmacia, Ciudad Univ., Madrid-3, España).

Morphol., systématique des Umbilicariaceae. Liste avec descr., hab., écol. de 21 taxons de la Sierra de Guadarrama. Diagn., descr., de *Umbilicaria crustulosa* subsp. *punctata* subsp. nov. Descr. de la forme des spores et du comportement écologique de *U. depressa*. Noter les stat. nov. : *U. hirsuta* subsp. *papygiria* (Ach.) (= *Gyrophora hirsuta* var. *pap.*), *Lasallia brisantium* subsp. *hispanica* (Frey) (= *U. brig.* var. *hisp.*). Clé aux taxons récoltés.

DIBBEN M.J. — The chemosystematics of the lichen genus *Pertusaria* in North America North of Mexico. Publ. Biol. Geol. (Milwaukee Public Mus.) 1980, 5 : 1-162, 136 fig., 29 tabl. (Dept. Bot., Milwaukee Public Mus., Milwaukee Wisconsin 53233 USA).

Morphol., chimie, géogr., écol., phylogénie, histor. du genre *Pertusaria*. Corrélations entre les caractères morphol. et chimiques des 6800 spécimens examinés. Mise en évidence de 40 substances lichéniques dont 6 sont nouv. La forme des apothécies et la structure de la paroi sporale permettent de diviser le genre en 2 sous-genres : *Pertusaria* (esp. type : *Pertusaria pertusa* (L.) Tuck.) et *Pionospora* (Th. Fr.) c. n. (esp. type : *P. bryontha* (Ach.) Nyl.). Dans chaque sous-genre les similitudes chimiques mettent en évidence des groupes d'esp. Clés aux 2 sous-genres et aux 66 esp. étudiées. Pour chaque esp. : taxonomie, descr., ill., affinités, données écol. et distr. 10 esp. et ssp. sont exclues de cette étude. Esp. nouv. : *P. floridana* (Floride), *P. hypothamnolica* (Illinois), *P. multipunctoides* (Caroline N), *P. santamonicae* (Californie), *P. subambigens* (Brit. Columbia), *P. suboculata* Brodo et Dibb. (Brit. Columb.), *P. sulcata* (Maine), *P. arizonica* (Texas), *P. californica* (Californie), *P. consocians* (Minnesota), *P. ostiolata* (Caroline N), *P. paratuberculifera* (New York), *P. shenandoensis* Hale et Dibb. (Virginie), *P. sinusmexicani* (Louisiane), *P. valliculata* (Arkansas). Comb. nouv. : *P. macounii* (Lamb) (= *Melanaria m.*).

ELIX J.A. and STEVENS G.N. — New species of *Parmelia* (Lichens) from Australia. *Austral. J. Bot.* 1979 (1980), 27, 6 : 873-883, 6 fig. (Chemistry Dept., Austral. Natl. Univ., P. O. Box 4, Canberra A.C.T., 2600 Australia).

Diagn., descr., de *Parmelia queenslandica*, *P. subtabacina*, *P. butleri*, *P. numinbahensis*, *P. springtonensis*, *P. norsticticata*, esp. nouv. d'Australie. Discussion autour de l'intégration des genres *Pseudoparmelia* Hale et *Parmelina* Hale. *Pseudoparmelia conlabrosa* Hale, *Relicina subconnivens* Hale et *Pseudoparm. neointartaria* Hale sont transférés à *Parmelia*.

FERRARO L.I. - Una nueva especie de Parmeliaceae para el NE Argentino. *Hickenia* 1979, 1 : 191-193, phot. (CONICET, Inst. Bot. del Nordeste, Casilla de Correo 209, 3400 Corrientes, Argentina).

Diagn., descr., ill. de *Parmotrema masonii* sp. nov. de Corrientes, affine de *P. delicatulum* (Vain.) Hale. Clé pour les deux esp.

HAFELLNER J. und POELT J. - Die Arten der Gattung *Caloplaca* mit plurilocularen Sporen (*Meroplacis*, *Triophthalmidium*, *Xanthocarpia*). *J. Hattori Bot. Lab.* 1979, 46 : 1-41, 44 fig. (Inst. Bot. Univ., A-8010 Graz).

Révision des *Caloplaca* ayant des spores pluriloculaires (le nombre de locules n'est pas un caractère taxonom. suffisant pour les diviser en plus. genres). Ces spores pluriloculaires semblent avoir évolué en 3 groupes. Clé aux 17 esp. et 1 sous-esp. reconnues. Pour chaque taxon : taxonom., descr. du thalle, des apothécies et des spores, distr. La plupart des esp. sont connues de quelques loc. seulement. Diagn., descr. de *C. araguana* sp. nov. du Venezuela, *C. crocea* ssp. *mexicana* ssp. nov. du Mexique, *C. oahuensis* sp. nov. des Iles Hawaï. Nom. nov. : *C. vainioi* (= *Placodium brebissonii* var. *microspora* Wainio). *Lecidea brebissonii* Fée, *L. crocea* Krempelh., *Blastenia kauaiensis* H. Magn., *Callopisma tetramera* Müll. Arg. sont transférés à *Caloplaca*. *Lecanora brebissonii* var. *subdecadens* Nyl. est une esp. de *Caloplaca*.

JORDAN W.P. - *Edrudia*, a new genus from California (Lichenes : Teloschistaceae). *Bryologist* 1980, 83, 1 : 64-67, 3 fig. (Dept. Biol., Univ. San Francisco, San Francisco, Ca 94117 USA).

Diagn., descr. de *Edrudia* Jordan gen. nov., se distinguant de *Polycauliona* Hue par des ascospores simples, des pycnidiospores filiformes et des rameaux du thalle dorsi-ventralement comprimés. *E. constipans* (Nyl.) c.n. (= *Placodium* c.).

NOBLE W.J. - *Catillaria columbiana* comb. nov. from Western North America. *Bryologist* 1980, 83 : 71-73 (Dept. Bot., Univ. British Columbia, Vancouver, BC, Canada V6T 1W5).

Descr., distrib. de *Catillaria columbiana* (Merr.) c.n. (= *Biatora* c.), corticole, de la Colombie britannique à la Californie.

POELT J. - *Physcia opuntiella* spec. nov. und die Lebensform der sprossenden Flechten. *Flora* 1980, 169, 1 : 23-31, 3 fig. (Inst. Bot., Univ. Graz).

Diagn., descr., ill. de *Physcia opuntiella* sp. nov., des localités sèches des Alpes. Formation de propagules segmentées, semblables à des levures et nommées blastides. Différents types de diaspores végétatives produites par les lichens.

PHYSIOLOGIE, CHIMIE

ASCASO C.A. — Rapid Method for the Quantitative Isolation of Green Algae from Lichens. *Ann. Bot. (London)* 1980, 45, 4 : 483 (Inst. Edafologia Biol. Veget., Serrano 115 bis, Madrid (6), Spain).

CZECZUGA B. — Investigations on Carotenoids in Lichens IV : Representatives of the Parmeliaceae Family. *Nova Hedwigia* 1980, 32, 1 : 105-111, 1 fig., 1 tabl. (Dept. Gener. Biol., Medic. Acad., 15-230 Białystok, Poland).

Chromatographie en colonne et en couche mince de 11 esp. de *Cetraria*, *Hypogymnia*, *Parmelia* et *Pseudevernia*. Sont isolés : neurosporène, lycopène, α -, β -, γ - et δ -carotène, époxyde β -carotène, α - et β -cryptoxanthène, canthaxanthène, lutéine, lutéine époxyde, zéa-, isozéa-, rubi- et astaxanthène, ester d'astaxanthène, violaxanthine, auro- et mutatochrome, mutatoxanthène, 3,4-didéhydrocolpène, flavochrome et capsanthine. Le plus riche est *Parmelia acetabulum*.

GREEN T.G.A., HORSTMANN J., BONNETT H., WILKINS A. and SILVESTER W.B. — Nitrogen fixation by members of the Stictaceae (Lichens) of New Zealand. *New Phytol.* 1980, 84, 2 : 339-348, 3 fig., 3 tabl. (Biol. Sci., Univ. Waikato, Hamilton, New Zealand).

44 esp. des Stictacées sont testées. 10 esp. dont le phycobionte est une algue verte n'ont pas d'activité nitrogénase.

LARSON D.W. — Seasonal change in the pattern of net CO₂ exchange in *Umbilicaria* Lichens. *New Phytol.* 1980, 84, 2 : 349-369, 2 tabl., 5 fig. (Dept. Bot. & Genetics, Univ. Guelph, Guelph, Ontario N1G 2W1).

Chaque esp. est adaptée uniquement aux conditions environnantes dans lesquelles elle pousse. Chacune peut maintenir une balance énergétique positive pourvu que sa distribution ne s'étende pas aux sites présentant des températures en excès par rapport à certaines valeurs.

MATHEY A. — Contribution à l'étude de la famille des Trypéthéliacées (Lichens Pyrénomycètes). *Nova Hedwigia* 1979 (1980), 31, 4 : 917-935, 23 fig. (Bot. Gart. & Bot. Mus., Berlin-Dahlem, D-1000 Berlin 33).

Mise en évidence, chez les Trypéthéliacées, de la pariétine et de la lichéxanthone, responsables de la couleur orangée ou jaune sale des verrues thallines ou de tout le thalle. Première isolation de l'acide sécalonique chez *Trypethelium eluteriae*. Analyse d'une coupe de *Laurera benguelensis*. Culture des mycosymbiotes de *T. kunzei* et de *T. catervarium*. Les substances produites par le mycosymbiote de *T. eluteriae* sont antifongiques, inhibant le développement d'*Aspergillus glaucus* et de *Penicillium* sp.

SHIMADA S., SAITO T., NAMIKI Y., SANKAWA U. and SHIBATA S. — New siphulin derivatives from the lichen *Siphula ceratites*. *Phytochemistry* 1980, 19, 3 : 467-469, 1 tabl. (Fac. Pharmac. Sci., Univ. Tokyo, Hongo, Bunkyo-ku, Tokyo 113, Japan).

Structure de 2 nouveaux chroménones métabolites : proto- et oxysiphuline.

RÉPARTITION, ÉCOLOGIE, SOCIOLOGIE

ASTA-GIACOMETTI J. — Flore et végétation lichéniques des Alpes nord-occidentales : écologie, biogéographie, écophysiologie, biodétection de la pollution fluorée. Thèse Univ. Sci. Méd. Grenoble, juin 1980 : 1-249, 71 tabl., 49 fig.

Description (géogr., climat., végétat.) de la région des Alpes nord-occidentales. Étude de la végétation lichénique (corticole, terricole et humicole, saxicole) et de ses relations avec l'altitude, les groupements forestiers, la nature du substrat. Comparaison de la flore lich. des Alpes nord-occidentales avec celle de la France, des Pays scandinaves. Rappelons que la région compte plus de 1200 espèces, soit plus de la moitié de la flore franç. Influence de quelques facteurs écologiques sur cert. associations et esp. lichéniques : CaCO_3 et pH pour les saxicoles, nutrition minérale (Ca^{++} , K^+ , Mg^{++}) des esp. terricoles et corticoles. Les lichens indicateurs de pollution : le fluor dans ces vallées alpines. Les résultats exposés selon ce plan sont le fruit de recherches effectuées seule ou en collaboration. Ils permettent de mettre en évidence l'importance de la végétation lichénique dans une étude écologique complète, et les relations entre le substrat, la végétation phanérogame, la pollution et les lichens. Bibliogr., liste des groupements lichéniques, liste des esp. (avec leur département de récolte, et, pour les macrolich., l'étage auquel ils appartiennent), glossaire viennent compléter cet important document. Un volume contenant les travaux déjà publiés sur ce sujet par J. Asta, est joint à la thèse proprement dite.

AWASTHI D.D. and JOSHI M. — Macrolichens of Mussoorie Hills, Uttar Pradesh. *Geophytology* 1977, 7, 1 : 91-97 (Dept. Bot., Lucknow Univ., Lucknow, India).

Liste avec loc. et quelques notes de 35 macrolichens, récoltées dans les collines de Mussoorie. Clés pour les esp. de *Collema*, de *Leptogium*, de *Parmelia*, d'*Usnea*, de *Pyxine*, de *Physcia* et d'*Heterodermia*.

AWASTHI D. D. and SINGH K. P. — Additions to the lichen flora of India IV. *Geophytology* 1977, 7, 2 : 276-277, 5 fig. (Dept. Bot., Univ. Lucknow, India).

Descr., ill. de *Phyllicum testudineum* A. Henssen nouv. pour l'Inde.

AWASTHI D.D. and DANGE K. — Additions to the lichen flora of India. V. *Natl. Acad. Sci. Letters* 1978, 1, 11 : 11-13 (Dept. Bot., Lucknow Univ., India).

Descr. d'*Acarospora fusca* B. de Lesd., *A. fuscata* (Nyl.) Arn., *A. oxytona* (Ach.) Mass. et *A. subfuscescens* (Nyl.) H. Magn. récoltés en Uttar Pradesh, nouv. pour l'Inde. Clé aux 13 esp. d'*Acarospora* connues en Inde.

AWASTHI D.D. and SHARMA L.R. — Additions to the lichen flora of Nepal. I. *Indian J. Bot.* 1978, 1, 1-2 : 139-141 (Dept. Bot., Lucknow Univ., India).

Descr. et loc. de *Anthroothecium himalayense* (Ras.) Awas., *Bombyliospora*

domingensis (Pers.) Zahlbr., *Cetrelia isidiata* (Asah.) Culb. et Culb. *Coccocarpia cronia* (Tuck.) Vain., *Haematomma puniceum* (Sw.) Mass., *Microglæna thelostomoides* (Nyl.), Zahlbr., *Parmelia subauriculenta* Nyl., *P. sublaevigata* (Nyl.) Nyl., *P. subsumpta* Nyl., *Phlyctella indica* Awas., *Physma byrsinum* (Ach.) Müll., et *Tylophoron moderatum* Nyl. nouv. pour le Népal.

BREDKINA L. I. — Lichenes montium Tian-Schan Centralis (Districtum Kockor et Naryn). *Nov. Sist. Nizsh. Rast., Bot. Inst. Komarova, Akad. Nauk SSSR* 1979, 16 : 115-127, fig., en russe.

Données ecol., végétation selon l'altitude. Liste de 57 lichens avec loc.

BJAZROV L.G. — *Usnea sulphurea* (Koenig) Th. Fr. ex Republica Populari Mongolia. *Nov. Sist. Nizsh. Rast., Bot. Inst. Komarova, Akad. Nauk SSSR* 1979, 16 : 127-129, en russe.

GOLUBKOVA N.S., SCHAPIRO I.A. — Species generis *Umbilicaria* Hoffm. em. Frey in URSS crescentes et examinatio earum chemotaxonomica. *Nov. Sist. Nizsh. Rast., Inst. Bot. Komarova, Akad. Nauk SSSR* 1979, 16 : 133-153, 9 tabl., en russe.

Distr. et chimiotaxonomie de 34 esp. d'*Umbilicaria*.

KIRBY N. — New additions to the Lichen Flora of the Burren. *Irish Nat. J.* 1980, 20, 1 : 45 (Dept. Bot., Univ. College, Galway).

7 lichens avec loc.

NOVRUSOV V.S. — Lichenes pro flora caucasi novi. *Nov. Sist. Nizsh. Rast., Inst. Bot. Komarova, Akad. Nauk SSSR* 1979, 16 : 155-158, en russe.

Liste de 35 esp. avec loc.

SINGH S.R. — A note on some macrolichen taxa from Pachmarhi, Madhya Pradesh, India. *Geophytology* 1977, 7, 1 : 123-125 (Dept. Bot., Lucknow Univ., India).

Liste de 16 taxons avec courte descr. et loc. au Pachmarhi.

SINGH S.R. and AWASTHI D.D. — A note on some micro-lichens from Pachmarhi, Madhya Pradesh, India. *Geophytology* 1978, 8, 1 : 127-128 (idem).

25 taxons avec loc. *Caloplaca festivella* (Nyl.) Kieff, *C. pellodella* (Nyl.) Hasse, *C. subnigricans* H. Magn., *Graphis subintegra* Red., *G. vittata* Müll. Arg., *Lecanora glabrata* (Ach.) Malme, *L. subcarnea* (Sw.) Ach. et *Ochrolechia africana* Zahlbr. sont nouv. pour l'Inde.

PENTECOST A. — The Lichens and Bryophytes of rhyolite and pumice-tuff rock outcrops in Snowdonia and some factors affecting their distribution. *J. Ecol.* 1980, 68, 1 : 251-267, 8 fig., 7 tabl. (Dept. Applied Biol., Chelsea College, London SW10 0QX).

La végétation de la rhyolite est dominée par *Lecidea tenebrica* tandis que

celle des pierres ponce volcaniques n'a pas d'esp. prépondérante. Ces dernières roches apparaissent plus poreuses, mais leur perte en eau est plus rapide que chez les rhyolites.

VARIA

BOTANICAL SOCIETY OF AMERICA – Abstracts of papers to be presented at the University of British Columbia, Vancouver, 12-16 July 1980. Miscellaneous Series Publications 1980, 158.

AHMADJIAN V. – Algal-fungal relationships in lichens; recognition, synthesis, development (Dept. Biol., Clark Univ., Worcester, Massachusetts 01610 USA). – AHTI T. – Morphological intergradation in local populations of *Cladonia* (lichenized Ascomycetes) (Dept. Bot., Univ. Helsinki, SF-00170 Helsinki 17). – EGAN R.S. – Studies on the Lichen Family Parmeliaceae in Texas : «Progress and Problems» (Dept. Biol., Univ. Nebraska at Omaha, Omaha NE 68182 USA). – EVERSMAN S. – Transmission electron microscope studies of lichens fumigated with air pollutants (Biol. Dept., Montana State Univ., Bozeman, Montana 59717 USA). – FAHSELT D. – Electrofocussed protein patterns in populations of fruticose lichens (Dept. Pl. Sci., Univ. Western Ontario, London, Ontario, Canada N6AN 5B7). – GARDNER C.R. and MUELLER D.M.J. – The effects of several lichenic acids on membrane permeability in *Funaria hygrometrica* Hedw. (Dept. Biol., Texas A & M Univ., College Station, Texas 77843 USA). – HALE M. E. – Importance of cortical structure in lichens (Dept. Bot., Smithsonian Inst., Washington D.C. 20560 USA). – LARSON D. – Low temperature effects on temperate species of *Umbilicaria* (Dept. Bot. & Genet., Univ. Guelph, Guelph, Ontario, Canada N1G 2W1). – LARSON D. – Morphological control of wetting in some lichens and mosses (Idem). – MALACHOWSKI J.A. – Status of *Usnea cavemosa* and *Usnea trichodea* in Eastern North America (Dept. Bot. & Pl. Pathol., Michigan State Univ., East Lansing MI 48824 USA). – MOSER T.J., NASH III T.H. and LONK S.O. – Photosynthetic patterns of dominant arctic lichens (Dept. Bot. & Microbiol., Arizona State Univ., Tempe, Arizona 85281 USA). – OTTO G.F. – Distribution of the lichen *Tholurna dissimilis* (Norm.) Norm. in North America (Dept. Bot., Univ. British Columbia, Vancouver, B.C., Canada V6T 2B1). – PEARSON L.C. – Air pollution increases leakage of electrolytes from lichen cells (Dept. Biol. Sci., Ricks College, Rexburg, Idaho 83440 USA). – RUNDEL P.W. – The relationships of morphological form and physiological response in coastal fog zone lichens (Dept. Ecol. & Evolut. Biol., Univ. California, Irvine, Ca 92717 USA). – SAYCE K. – SEM observations of the algal-fungal interactions : methods for increased clarity (Bot. & Microbiol. Dept., Arizona State Univ., Tempe, Arizona 85281 USA). – SIGAL L.L. – The effects of peroxyacetyl nitrate fumigations on lichens from southern California forests (Oak Ridge National Lab., Environm. Sci. Div., P. O. Box X, Oak Ridge, TN 37830 USA). – SIMONSEN P. – Microorganisms associated with non-symbiotic nitrogen fixation in boreal forests

and eastern hardwood forests (Dept. Forests Sci. & Soil Sci., Univ. Alberta, Edmonton, Alberta, Canada T6G 2E3). – SLOCUM R.D. – Light and electron microscopic investigations in the Dictyonemataceae (Basidiolichens) (Cell Research Inst. & Dept. Bot., Univ. Texas, Austin, TX 78712 USA). – SMITH C.W. – The lichen and bryophyte flora of fumaroles in Hawaii Volcanoes National Park (Dept. Bot., Univ. Hawaii at Manoa, Honolulu, HI 96822 USA). – WOOD J. – Relationship between water content and morphology of *Ramalina menziesii* Tayl. along an altitudinal gradient (Dept. Biol. Sci., Univ. California, Santa Barbara, California 93106 USA).



INFORMATIONS

Vient de paraître :

TAYLOR R.J. and LEVITON A.E. ed. — The Mosses of North America. San Francisco. Pacific Div., Amer. Assoc. Advanc. Sci., 1980, 170 p., ill. (communications bryol. au 59e meeting annuel. — Prix : \$ 11.95 U.S., auprès de Secretary, Pacific Division, AAAS, C/o California Academy of Sciences, San Francisco, Ca 94118, USA).

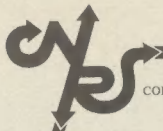
CATCHESIDE D.G. — Mosses of South Australia. South Australia, Woolman 1980, 364 p., ill. (prix : \$ 13.20, auprès de Publications officer, 282 West Beach Rd, Netley 5037 South Australia).

LANDWEHR J. — Atlas van de Nederlandse Levermossen. Zutphen, Thieme et Cie, 1980, 288 p., ill. (prix : DFL. 45, auprès de Konink. Ned. Natuurhist. Vereniging, B Hoogenboomlaan 24, 1718 BJ Hoogwoud, Holland).

ZEHR D.R. — An assessment of variation in *Scapania nemorosa* and selected related species (Hepatophyta). *Bryoph. Biblioth.* 1980, 15 : 1-140, ill. (prix : DM. 40, auprès de Cramer J., D-3300 Braunschweig, in den Springäckern 2).

CRUM H.A. and ANDERSON L.J. — Mosses of Eastern North America. New York, Columbia Univ. Press, 1981, 2 vol., 1328 p., ill. (prix : \$ 78.00 US).

Ces ouvrages seront analysés dans *Cryptog., Bryol. Lichénol.* 1981, 2, 2.



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SOMMAIRE

R.H. ZANDER. — Descriptions and illustrations of <i>Barbula</i> , <i>Pseudocrossidium</i> and <i>Bryoerythrophyllum</i> (p. p.) of Mexico	1
R. GAMBARDELLA, R. LIGRONE AND R. CASTALDO. — Ultrastructure of the sporophyte foot in <i>Phaeoceros</i>	23
P. TIXIER. — La notion d'espèce chez le genre <i>Cololejeunea</i> . Le complexe <i>Cololejeunea floccosa</i> (Lehm. & Lindenb.) Schiffn.	47
S.S. KUMAR & S.K. VERMA. — Cytological observations on some West Himalayan mosses. VI	77
E.A. ODU. — Reproductive phenology of some tropical African mosses. .	91
D. GRIFFIN, III. — Spore ornamentation in <i>Leiomela</i> (Musci : Bartramiaceae)	101
BIBLIOGRAPHIE BRYOLOGIQUE	107
BIBLIOGRAPHIE LICHÉNOLOGIQUE	119
INFORMATIONS	126